# Almond Pest Management Alliance
# Year-End Report

**Contract Title: "TO PROMOTE A REDUCED-RISK SYSTEM OF ALMOND PRODUCTION THROUGH ALTERNATIVE PRACTICES"**
**Contract Number: 97-0281**

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***Prepared for California Department of Pesticide Regulation***

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**ABSTRACT**

The Almond Pest Management Alliance (PMA) was formed by the California almond industry in 1998 to evaluate the possibility of managing pests with less disruptive pesticides. The Almond Board of California initiated discussions among industry stakeholders for the purpose of determining the feasibility of applying for a grant from the California Department of Pesticide Regulation to study reduced risk approaches.

Members of the PMA are: The Almond Board of California, Almond Hullers and Processors Association, Community Alliance With Family Farmers, University of California Statewide IPM Project, and University of California Cooperative Extension (UCCE) almond farm advisors.

The proposal "To Promote a Reduced-Risk System of Almond Production Through Alternative Practices" was funded with a $99,000 grant for the crop year August 1, 1998 to July 31, 1999.

The project was divided into three regional projects because of the vast size of the almond industry. Regional plots were established in the Northern Sacramento Valley (Butte County), the Central San Joaquin Valley (Stanislaus County), and the Southern San Joaquin Valley (Kern County.)

The purpose of each regional project was to compare "conventional" versus "reduced risk" approaches to treating pest problems.

Each project involved a local grower-cooperator who allowed division of an orchard into a "conventional" block—versus a "reduced risk" block. A UCCE almond farm advisor supervised each project with the assistance of a field scout.

The target pests addressed in all three regional projects included Navel Orangeworm (NOW), Peach Twig Borer (PTB), San Jose scale, mites and ants.

An important component of the project was outreach to growers to educate them about the days in each region, and the production of two newsletters mailed to growers and interested parties that included issues involved in pesticide use and possible reduced risk scenarios. Because this is the first year of a multi-year project, the conclusions to be drawn are not definitive.

However, in general, the project demonstrated:

- Reduced risk scenarios can work for some pests in some areas.
- Extensive orchard monitoring is key to the success of this approach. Growers need to make the commitment to knowing what is happening in their orchard.
- Reduced risk may not necessarily be reduced input.

## BODY OF REPORT

## INTRODUCTION

The Almond Pest Management Alliance (PMA) was funded by a $99,000 grant awarded by the California Department of Pesticide Regulation (CDPR) for the crop year August 1, 1998 to July 31, 1999. The proposal is titled "To Promote a Reduced-Risk System of Almond Production Through Alternative Practices."

Members of the PMA are: the Almond Board of California, Almond Hullers and Processors Association, Community Alliance With Family Farmers, University of California Statewide IPM Project, and University of California Cooperative Extension (UCCE) almond farm advisors.

Structurally, the Almond PMA is run by a management team composed of representatives from each of the identified organizations, as well as a private Pest Control Advisor (PCA.) The team meets on a quarterly basis to review the project's progress and make decisions about its future course. The Almond Board of California oversees the administrative functions.

Upon its formation, the Almond PMA set these basic objectives:

- Establish demonstration orchard sites in three different almond-growing regions to collect data on almond pest management practices that reduce risks associated with pesticide use.
- Conduct orchard monitoring and specific research activities that address localized pest control and almond production practices.
- Provide almond growers with information on available pest control tactics, including the use of economic thresholds, so they can make informed choices about alternatives to preventative disruptive sprays.
- Promote the program to growers to ensure California almond growers understand the need for a reduced risk system. Educate growers about alternative farming practices that have the potential to reduce pesticide use and sustain profitability.
- Evaluate the risk reduction achieved as a result of this project by producing a final report that includes not only a projection of the risk reduced, but also a discussion of the costs and benefits of the solution and the practicality of adoption.

The need for this project is provided by two major concerns:

1) Implementation of the federal Food Quality Protection Act (FQPA), and the possible loss of some traditional crop protection tools, which have been available to almond growers over the past several years.
2) Increasing public and regulatory concern over water quality standards on the San Joaquin River and Sacramento River watersheds, with possible links to pesticides, particularly dormant sprays, used by almond growers.

The target pests addressed across all three regional projects are Navel Orangeworm (NOW), Peach Twig Borer (PTB,) San Jose scale, mites and ants. These pests, in general, pose the greatest economic challenge to California almond growers.

The PMA views this project as an efficient way to bring together many years of research which have been spent on alternative and reduced risk management techniques, and to apply practically the vast body of knowledge accumulated over the years by the University of California.

The Almond Board of California has been supporting an Integrated Pest Management (IPM) system for more than 25 years. During the 1997-98 crop-year, the Almond Board funded ten IPM projects for a total of $190,270. These projects have helped reduce the use of pesticides through such studies as: Navel Orangeworm, Orchard Sanitation, and Early Harvest Reducing Dormant Spray Hazards, Pheromones for Peach Twig Borer, and Alternatives for Soil Fumigation with Methyl Bromide. Results of these research projects are available from the Almond Board of California.

The Board has also received an "IPM Innovator Award" from CDPR for its innovative leadership role in the field of IPM.

The UC Statewide IPM Project is well recognized for its national leadership on IPM. The IPM Project publishes the well-respected *IPM for Almonds Manual.* This publication states, "A good IPM program coordinates pest management activities with cultural operations to achieve economical and long-lasting solutions to pest problems."

Reduced risk strategies such as CAFF's Biologically Integrated Orchard Systems (BIOS) program seek to demonstrate that a small, but growing number of almond producers have been successfully reducing their insecticide, herbicide, and fertilizer inputs without affecting yield or quality. Most program growers have experience with individual components of the system, such as Bt sprays and insect releases. By combining these with seeded cover crops, modified mowers, increased monitoring, and habitat enhancement, BIOS growers have replaced the broad-spectrum chemical control on their farms with biological processes and selective insecticides

## EXECUTIVE SUMMARY

The Almond Pest Management Alliance (PMA) was formed in 1998 to evaluate the possibility of managing pests with less disruptive pesticides.

The impetus for this collaborative approach grew out of two major concerns: Implementation of the Food Quality Protection Act (FQPA) with possible loss of some traditional crop protection tools, and growing public concern over water quality standards in the San Joaquin River and Sacramento River watersheds, with possible links to pesticides used by almond growers.

The Almond Board of California initiated discussions among various industry stakeholders to look at the possibility of forming a cooperative effort to pursue a grant available from the California Department of Pesticide Regulation. Those industry stakeholders include the Almond Board of California, Almond Hullers and Processors Association, Community Alliance With Family Farmers, University of California Statewide IPM Project, and University of California Cooperative Extension (UCCE) almond farm advisors.

The proposal "To Promote a Reduced-Risk System of Almond Production Through Alternative Practices" was funded with a $99,000 grant for the crop year beginning August 1, 1998 through July 31, 1999.

The PMA set up three regional projects due to the enormous scope of the California almond industry (nearly 480,000 producing acres ranging from Chico in the north to Bakersfield in the south), and the wide range of pests and various treatments used in different regions. Those projects were located in the Northern Sacramento Valley (Butte County), the Central San Joaquin Valley (Stanislaus County) and the Southern San Joaquin Valley (Kern County.)

Each project had an essential component: A local grower-cooperator who agreed to let his orchard be divided so that it would reflect "conventional" pesticide treatments as opposed to "reduced risk" approaches. Again, the interpretation of "conventional" versus "reduced risk" varies from region to region depending upon factors such as soil, climate, disease and pest pressures.

Each project was under the direct supervision of a UCCE farm advisor. Each advisor established the plot to best address local pest concerns and growing conditions that would be relevant to local growers. The advisors employed a field scout who performed the extensive monitoring required for such a project. The target pests addressed across all three projects included Navel Orangeworm (NOW), Peach Twig Borer (PTB), San Jose scale, mites and ants.

The body of this report provides in detail how each regional project compared "conventional" versus "reduced-risk" treatments and offers the results in terms of damage from the target pests within the parameters of the two treatments.

It is important to note that there can be no definitive "conclusions" drawn from the first year of this study. A multi-year study is needed to make a science-based conclusion about these various approaches.

However, some general conclusions can be drawn from the first year:

- Grower education and outreach is a critical factor in enabling growers to make informed choices about alternatives to certain pesticides. The Almond PMA is proud of its outreach efforts. In this report, the PMA has documented the two fields days held in each of the three regions. All of the field events were well attended, drawing approximately 100 growers and Pest Control Advisors (PCA's) to each event. Additionally, a newsletter was produced in the fall and spring and mailed to approximately 7,000 growers and interested parties.
- UC involvement lends scientific credibility to the project. The UC is well respected as s source of factual, objective information. Growers and PCAs attending the field days can have confidence that sound methodology is being employed.
- Local grower-cooperators are willing to take a risk and be innovative. There is a risk in allowing innovative approaches to be used, and the cooperators should be recognized for their leadership role in communication to be successful. Administering a grant of this size both in terms of dollar amount and the number of participants requires considerable resources and time commitment by all the collaborators.
- Projects of this scope require significant infrastructure and intensive internal communication to be successful. Administering a grant of this size both in terms of dollar amount and the number of participants requires considerable resources and time commitment by all collaborators.
  The Almond PMA is run by a management team comprised of farm advisors, a private PCA and representatives from each of the collaborating organizations. The team meets on a quarterly basis to review the project and make decisions about its future course.

In general, the management team believes future improvements should include:

- Standardization of reporting by the three project farm advisors is needed so results are better interpreted. This is an area of improvement being actively pursued in year two.
- Increased monitoring of pests and diseases in each of the three projects.

In conclusion, the Almond PMA in its first year demonstrated the following:

- Reduced risk scenarios can work for some pests in some areas.
- Extensive orchard monitoring is key to the success of this approach. Growers need to make the commitment to knowing what is happening in their orchard.
- Reduced risk may not necessarily be reduced input.
- There needs to be a commitment to multiyear funding to obtain scientifically valid data on which growers and their PCAs can make sound economic and environmental decisions.

## MATERIALS AND METHODS

The Almond PMA is designed to be demonstration project, with grower-cooperators in three regional areas. In these orchards, the data collected can enable the almond growing community to see a reduced risk system in action. With the information provided by the Alliance, growers and their Pest Control Advisors (PCAs) can see first-hand the monitoring techniques, the economics, the yields, the practices used and even talk with the grower himself about how the project works.

The three regional projects were set up in the following manner:

### Stanislaus County

*(The following information is taken from the year-end summary for this regional project. A complete copy of the year-end summary is attached as appendix #1)*

The Stanislaus County PMA site is a research trial as well as a demonstration. The trial is being conducted in a uniform 120-acre orchard (Nonpareil: Carmel) west of Modesto. Three insect pest management program treatments are fully replicated three times within the 120-acre orchard. Each plot is approximately 13.5 acres in size. The treatments are:

**Grower's Standard Practice:** This pest management program is fairly common in the Northern San Joaquin Valley. While most growers in this area apply a hull split spray for naval orangeworm control, our cooperator elects to target peach twig borer with a May spray. Specifically, pesticide treatments included:

- A dormant application (1-21-99) of Asana XL (a pyrethroid) @ 8 oz, Kocide DF @ 8 lb, and Gavicide Super 90 @ 6 gallons (6%)
- A May spray (5-20-99) of Lorsban 4E (an organophosphate) @ 4 pints + 12.8 oz Nu-film 17.
- Omite was applied to the northwest corner (approximately four acres) of Replication 1 on 7-12 due to an increase of Pacific mites (an area historically prone to mite buildup). On August 5 the entire replication (13 acres) was treated with Omite as mites were beginning to build and the cooperator was concerned about the 30-day pre-harvest interval.

**Intermediate Program:** In these areas, "reduced risk" pesticides are used. Specifically, pesticide treatments included:

- A dormant application (1-21-99) of Success @ 6.4 oz, Kocide DF @ 8 lb, and Gavicide Super 90 @ 5 gallons (5%)
- A May PTB spray (5-21-99) of Success @ 6.4 oz.
- Agri-Mek 0.15 EC @ 10 oz & Gavicide Super 90 @ 1 gallon were included in the May spray because mite populations were beginning to build in Replication 1 only.

**Soft program:** Pesticide treatments included:

- A dormant application (1-21-99) with oil only (Gavicide Super 90 @ 6 gallons)
- Two bloom applications of Bt (Dipel DF @ 1.5 lb on 3-2 and 3-16). These coincided with normal fungicide applications and therefore did not necessitate additional application costs
- Two May PTB sprays of Bt (Dipel DF @ 1.5 lb on 5-14 and 5-24)
- Agri-Mek 0.15 EC @ 10 oz & Gavicide Super 90 @ 1 gallon for Replication 1 only (5-24)

All dormant and in-season sprays were applied in approximately 100 gallons of water per acre. Mummies were removed and destroyed in all treatments. Mummy counts were recorded on February 12 & 15, 1999 and averaged 0.4 mummies per tree. There were no differences between treatments. Cover crop management (periodic mowing of native vegetation), fertilization, and fungicide treatments did not differ between treatments. A nutrient buffer product (10-12-0) was included in the May sprays for all treatments.

**Kern County**

*(The following information is taken from the year-end summary for this regional project. A complete copy of the year-end summary is attached as appendix #2)*

There were two 40-acre blocks of hard shell varieties (Butte, Mission, and Padre), and two-40 acre blocks of soft shells (Nonpareil, Sonora, and Fritz). Each 40-acre block was divided into reduced input and conventional blocks. The demonstration was started in November 1998, with the planting of a cover crop and has continued until the present time.

**Conventional Plot**

Dormant spray: Diazinon & oil
July spray: organophosphate (Phosmet)
Mites: propargite (Omite)
Ants: abamectin (Clinch)
Fungicides: iprodione (Rovral)

**Reduced Risk – Soft Plot**

Dormant spray: oil only
Bloom spray: Bt (3 ap's)
July spray: spinosad (Success)
Mites: preditory mite release
Ants: abamectin (Clinch)
Fungicides: iprodione (Rovral)

**Cover Crop**

Barley was selected as the cover crop because of the saline-alkali and poor drainage condition of the soil. The barley was seeded in every middle on both soft and hard shell blocks at a rate of 40 lbs. per acre. This was done in late November. At this time, an insectary was established on every 11th middle using the 1998 "BIOS Insectary Mix" (See Appendix B for mixture composition). The rate of seeding was 10 lbs. per acre.

The barley germinated well and created a solid cover. It did improve the drainage of the soil and provided a cool environment. The insectary mix didn't do that well. The clovers, rye, vetch, coriander and celery didn't germinate at all, and a limited number of toothpick weed and yarrow plants were present in the middles.

**Pest Monitoring**

Trapping for three key pests of almonds was done throughout the season. Traps were hung together on the same tree, seven trees in from the end of the row in Nonpareil and Mission varieties. Three San Jose Scale sticky traps were placed per block, six to seven feet high in the northeast quadrant of the tree on February 22, 1999, and were monitored weekly until the end of November. Pheromone lures were replaced every four weeks. Adult San Jose Scale moths were counted, as well as the *Prospaltella* and *Aphytis* adults. Double-sided sticky tapes were placed one per tree in each of the four trees surrounding the "trap tree" on April 15, 1999, and were collected and replaced every other week through November. The number of San Jose Scale crawlers per tape were then counted and recorded. Two peach twig borer traps were placed per block, six to seven feet high in the northeast quadrant of the tree on March 22, 1999; adult moths were counted weekly until the end of November. Pheromone lures were replaced every eight weeks. Two navel orangeworm traps per block containing an almond meal mixture were placed six to seven feet high in the north side of the tree on March 29,1999; eggs laid on the exterior grooves of the trap were counted weekly through the end of November. Bait was replaced every eight to ten weeks.

**Dormant Spray**

The dormant spray was done in the conventional blocks on January 4, 1999. It consisted of five pints of Diazinon and six gallons of oil in 200 gallons of water per acre. The reduced pesticide input was left unsprayed. The dormant spray treatment gave us mixed results for key pests in almonds. Table 1 shows that the dormant spray did not affect PTB emergence. One can also say that dormant spray didn't completely eliminate the PTB in the orchard.

**Butte County**

*(The following information is taken from the year-end summary for this regional project. A complete copy of the year-end summary is attached as appendix #3)*

This orchard is approximately 49-acres. The grower's standard block is 27-acres, the PMA block is 22 -acres divided into a 12-acre soft treatment and a 10-acre organophosphate dormant treatment. Five of these 10-acres received an organophosphate hullsplit spray. Traps for San Jose Scale, Peach Twig Borer, and Navel Orangeworm were placed on the north side of the center Nonpareil row in each block and monitored weekly.

**Dormant OP Plot**

Dormant: organophosphate (Diazinon), oil & copper
Hullsplit spray:
    a) organophosphate (Lorsban)
    b) no organophosphate
Fungicides: myclobutanil (Rally)
    cyprodinil (Vanguard)

**Reduced Risk - Intermediate**

Dormant spray: none
Bloom spray: Bt (2 ap's)
May spray: none
Fungicides: iprodione (Rovral)
    propiconazole (Break)
    Captan (2)

**Reduced Risk - Soft**
Dormant spray: none
Bloom spray: Bt (2 ap's)
May spray: none
Fungicides: myclobutanil (Rally)
cyprodinil (Vanguard)

**Insecticide and Disease Control Applications (see Appendix 1)**
**Grower's Standard Practice 27 acres**: Rovral, oil, and 10-52-10 was applied on 2/20/99, however, due to rain, only half of the orchard was treated. The second half of this spray application was on 2/26/99. Rovral was applied at 0.8 pounds per acre, oil at 1 gallon. /ac, and 10-52-10 at 4 pounds per acre. On 3/9/99 Break was applied at 4 ounces per acre, Condor at 2 pints per acre, and 20-20-20 at 4 pounds per acre. Captan at 8 lbs/ac and Condor at 2 pints/acre was applied on 3/22/99. A final Captan was applied at 8 lbs/ac on 4/15/99.

**PMA Soft Approach 22.5 acres**: Rally and 10-52-10 was applied on 2/23/99 and 2/26/99 in alternate rows at rates of 6.4 ounces and 4 pounds per acre respectively. Vangard was applied on 3/9/99 to all 22.5 acres.

**Soft 12.5 acres of 22.5**: Vangard at a rate of 5 ounces plus Condor at a rate of 2 pints, and 20-20-20 at a rate of 4 pounds per acre was applied on 3/9/99. An additional Condor spray was applied on 3/22/99.

**Dormant Spray Comparison (10 acres of the 22.5)**: Diazinon was applied at 4 pints, Kocide applied at 8 pounds, and oil applied at 4 gallons per acre on 1/28/99.

**Hullsplit Spray 5 acres:** Lorsban at 4 pints was applied 7/27/99 to 5 acres of the 10 acres receiving the Dormant spray.

**Orchard Floor Management (See Appendix 2)**
**Strip Sprays**: On 2/5/99 the strips in the tree row were treated with Roundup original at 3 pints per acre plus Goal at a rate of 6 ounces per acre. On 5/6/99, Roundup at 3 pints/ac was applied again to the strips. A final Roundup strip spray was completed on 6/24/99.

**Solid Middles treatment:** Roundup original was applied at 2 pints on 7/9/99 and again on 8/13/99 as a pre-harvest clean up spray.

**Mechanical Chopping:** Solid chops occurred on 3/10 and on 8/7. Alternate middle chopping occurred on 4/13, 4/28, 5/24, 6/16, 6/28, and 7/1. Normal orchard floor management practice in the orchard is to chop every-other middle and then chop the alternate middles the next time.

## RESULTS

- The Almond PMA project was successful in its first year in meeting the overall objectives it set forth in its original proposal.
- Additionally, each of the regional projects achieved measurable results.
- First, a comparison of the original objectives to the results obtained.

## Overall Project Results

- **Establish demonstration orchard sites in three different almond-growing regions to collect data on almond pest management practices that reduce risks associated with pesticide use.**

All three regional projects were successfully established. Two field days were conducted in each region in the winter and spring.

- **Conduct orchard monitoring and specific research activities that address localized pest control and almond production practices.**

The local farm advisor closely observed each PMA demonstration site, and local field scouts for insect pests, beneficial insects, and diseases monitored each of the blocks weekly. This monitoring information is critical in decision making in reduced-risk plots. The data was made available for viewing on the PMA website, was incorporated into PMA newsletters distributed to growers statewide, and was compiled into final regional reports included as part of this document.

- **Provide almond growers with information on available pest control tactics, including the use of economic thresholds, so they can make informed choices about alternatives to preventative disruptive sprays.**

Through a series of field days and newsletters, information posted to the Almond PMA website and news articles and grower to grower information sharing, the Almond PMA was effective in providing almond farmers with the information they needed to begin to implement reduced risk systems on their farms. The project emphasized to growers the importance of keeping historical records of their orchards, monitoring and making critical observations in their orchards. The PMA is providing growers with an understanding of the problems facing the grower community and offering alternatives that can benefit the farmer, the environment and human health.

- **Promote the program to growers to ensure California almond growers understand the need for a reduced risk system. Educate growers about alternative farming practices that have the potential to reduce pesticide use and sustain profitability.**

The outreach component of the project was very effective. The two editions of the Almond PMA newsletter (See Appendix #4) were distributed to over 6,000 growers, PCA's and industry representatives. Field days allowed growers to find out about the problems associated with pesticide use and the possible alternative solutions available.

Extensive efforts were made to inform growers about PMA field days. Direct mail flyers, press releases and Internet outreach (See Appendix #5) helped create awareness within the industry.

About 600 growers and pest control advisors attended these field days and workshops in Year 1, and the numbers at these field days kept growing, indicating an increasing interest in reduced risk management practices. Overall, grower reaction to the field days was positive, as documented in surveys conducted at each of the field days (See Appendix #5)

Information and outreach by local farm advisors also helped convey the message that reduced risk practices are needed in the industry and that there are viable alternatives available. A half-page ad in "Nut Grower" magazine sponsored by CAFF and the Almond PMA was seen by several thousand growers (See Appendix #6) and helped raise awareness of the PMA project.

An opinion piece by PMA Administrator Mark Looker in the "Modesto Bee" (See Appendix #7) also received wide distribution and helped explain the purpose and goals of the Almond PMA to urban and agricultural readers and opinion leaders.

The PMA also provided an opportunity to conduct educational outreach with a variety of industry groups, schools, legislative and governmental regulatory agencies (See Appendix #8). The Final Report on PMA Year One is being shared with growers through newsletters, the PMA website and meetings with the aid of a PowerPoint presentation (See Appendix #9)

- **Evaluate the risk reduction achieved as a result of this project by producing a final report that includes not only a projection of the risk reduced, but also a discussion of the costs and benefits of the solution and the practicality of adoption.**

The consensus from the local farm advisors who know firsthand about each of the demonstration orchards is that one year of data on production and costs is not sufficient information on which growers can base a decision about whether to adopt some of the alternative practices outlined in this project. A multi-year project will offer a much stronger base of knowledge for growers and PCA's to make an informed decision.

Economic analysis of the cost of "conventional" versus "reduced risk" approaches was completed as a component of two of the three regional projects' year-end reports. That comparison, by regional project, is as follows:

**Stanislaus County -**
**Cost Comparison**

| | |
|---|---|
| Conventional: | $125.19/ac |
| Reduced Risk - Intermediate: | $157.95/ac |
| Reduced Risk - Soft: | $144.22/ac |

**Butte County -**
**Cost Comparison**

| | |
|---|---|
| Dormant OP with hullsplit: | $93.39/ac |
| Dormant OP without hullsplit: | $71.77/ac |
| Reduced Risk - Intermediate: | $86.35/ac |
| Reduced Risk - Soft: | $57.15/ac |

**Kern County -**
**Cost Comparison**

Economic analysis was not available for Kern County at the time of this report.

**Regional Project Results**

Each of the three regional projects was able to produce tentative measurable results. All of the UCCE farm advisors cautioned that the results are much too preliminary after only one year and should not be used as a basis for reaching definitive conclusions about the merits of the various practices employed by each project. Again, a multi-year project is necessary to produce sound scientific data. The results, by regional plot, are as follows:

**Stanislaus County**

This orchard has a history of being very clean with a very low reject level. It was a low pest pressure year with few NOW, PTB and ants. Shell seals were very tight. The dormant pyrethroid application decreased the San Jose scale population along with the beneficial populations.

**Butte County**

This orchard also has a history of low reject levels. Very little difference in damage from NOW, PTB, Oriental Fruit Moth and ants could be detected between the various treatments. There was also little difference in disease between the various treatments.

The reduced risk and intermediate plot has the lowest levels of San Jose Scale and parasites. The plot with a dormant OP application and hullsplit OP had the lowest level of San Jose scale and high levels of parasites.

**Kern County**

In the plot treated with a dormant OP, the reject level was .26%, while the reject level in the reduced risk plot was .06%

There was no significant difference in PTB between the two treatments.
The level of San Jose Scale was lower with the dormant and in-season OP treatment.
There was no significant difference in mites between the two treatments.
There were fewer ants with the dormant OP treatment.

**Additional Measurement Of Grower Practices**

In an effort to gain important baseline information about current grower practices, the PMA and CAFF completed in the summer of 1999 a survey of 485 almond growers throughout the state. This telephone questionnaire asked growers about their pesticide use, management practices, pest monitoring, how they make pest management decisions, and what they use as sources of information for their farming operation.

A final survey report prepared by the Almond PMA will attempt to show what management practices growers are using, what chemical applications they make, how they get their information and what biological products they are applying. A copy of this report will be forwarded to DPR when completed. The results of the survey will be a closer look at grower practices in almonds and provide significant baseline data for future reduced risk efforts.

## DISCUSSION

Each of the three regional project farm advisors was asked to offer their comments on the success of the first year of the PMA project.

**Stanislaus County Farm Advisor — Roger Duncan**

It is vital that information from projects like this be collected for multiple years or else the project is meaningless. It can sometimes take 2-3 years before significant shifts in pest populations occur. At this time there are no reasons to make significant changes in the Year Two work plan. Most growers will not adopt major changes in management philosophy unless they can watch the alternatives over a period of time. If through their observations they become confident in a new system, they will adopt it. It will take at least three seasons of data to convince most growers. It is a must to continue this project for several more seasons.

**Kern County Farm Advisor Mario Viveros**

The PMA project has allowed us to evaluate conventional pest management practices in the Southern San Joaquin Valley. We validated the value of some pesticides and we were surprised by the poor performance of others. We found that biological control can work for some pests but not for others. It was our understanding that dormant sprays were the best time to control PTB. This was not the case in the PMA orchard. Both dormant and non-dormant sprayed blocks had the same adult population and the same number of shoot strikes. Furthermore, the reject levels were greater on the dormant sprayed (0.26%) than on the non-dormant sprayed (0.06%).

PTB can also be out of control at bloom time. From monitoring PTB emergence and bloom, we found that only one of the two or three Bt (Bacillus thuringiensis) sprays can be combined with the bloom spray. If a grower wants to control this pest, he will have to come back with one or two additional sprays at seven- or ten-day intervals. The data from the PMA project demonstrates the need for developing economic thresholds for PTB. Both the adult population and shoot strikes were very high but the reject levels for PTB were less than one percent.

Dormant sprays did control San Jose scale (SJS) and reduced the ant population throughout the season. At harvest time, the ant population in the dormant-sprayed block was reduced by 54%. The reject level due to ants was less in the dormant-sprayed blocks than in the non-sprayed blocks. This also demonstrates the need for research on ant control during the dormant season.

We were successful in managing spider mites. The orchard was kept well watered. Based on mid-day stem water potential, the orchard never showed any major stress. The stress level varied from ideal to mild stress. Also, western predatory mites were released as soon as there was a food source. Two applications of 2,500 predatory mites per acre were made: one on July 19$^{th}$ and the second on August 11th. After the second application, the mites were under control and no additional application of mites was necessary.

The PMA project clearly demonstrated that monitoring is the key for the success of a pest management program. The University of California has developed large amounts of pest and disease information but none has any value if it is not implemented in a pest and disease-monitoring program. By monitoring the PMA orchard, we have discovered the dormant sprays are not controlling PTB, a key pest in almond orchards. On the other hand, dormant sprays may help in the control of ants. Monitoring the water status of the almond trees and mite populations allows management of mites without the use of Omite. Monitoring pests and diseases is not inexpensive. It costs three hours-per-acre in the PMA project. However there is no other orchard activity that can provide first-hand knowledge on what insects and diseases are doing in an orchard. Knowledge is a must to manage our insects and diseases in an effective manner. The success of this project for the first year can be summarized in the following areas:

**PMA as a teaching tool**

- Growers have become aware of the importance of effective winter sanitation.
- Growers have learned about the basic information the industry has on San Jose Scale control
- Growers became aware of the importance of spray coverage. You can't have an effective program without good coverage.

**PMA as a Demonstration Tool**

We have a golden opportunity to assess and compare a reduced risk pesticide management system with a conventional system.

- To demonstrate the proper management of a cover crop in an almond orchard
- To demonstrate the intensity and amount of work required by a quality pest monitoring system.
- To demonstrate the integration of all knowledge on horticulture, entomology, and plant pathology in an almond management system.

**The Value**

This project has demonstrated that a reduced risk pesticide system in an almond orchard requires an intensive monitoring program. This project shows that before a grower reduces the amount of pesticides in his orchard he must invest time gathering information about his orchard.

**Butte County Farm Advisor — Joe Connell**

In order to see real differences between different treatments, the project needs to be multi-year. In the Northern growing region, the monitoring approach to disease control could serve to lower growers' production costs. The almond industry in the Northern Sacramento Valley was very interested in this PMA project. The turnout at field days was very good.

## SUMMARY AND CONCLUSIONS

The first year of the Almond Pest Management Alliance has clearly shown that the Almond PMA is an effective starting point for growers and Pest Control Advisors who are interested in learning about reduced risk systems. The impending loss of some traditional crop protection tools due to FQPA implementation, the possible risks to water quality from some dormant sprays, and a renewed interest in farming with more sustainable practices all point to the importance of the PMA project.

The Almond PMA was begun as a collaborative effort to address some of the pressing pesticide issues facing the state's $1 billion almond industry. The almond industry showed its willingness to provide leadership by working together with a broad array of partners. The Almond Board of California, the Almond Hullers and Processors Association, the Community Alliance With Family Farmers, the UC Statewide IPM Project and the UC Cooperative Extension almond farm advisors have all been focused on the goal of helping almond growers deal with the challenges presented by public concern over the use of pesticides.

The Almond PMA in its first year demonstrated the power of pooling resources to educate growers about reduced risk approaches. By working together, the various partners were able to reach more growers and Pest Control Advisors than any one individual organization could have reached on its own. UC farm advisors were able to have their limited resources expanded by the talents offered by PMA partners, whether in mailing out field day flyers, staffing sign-in booths, arranging for field day lunches or paying the salaries of field scouts who do the critical monitoring work.

By speaking with one voice on the critical issue of pesticide use, the Almond PMA has done much in the past year to raise awareness among growers.

This collective voice has also been valuable in helping educate governmental regulatory agencies about the many complex issues involved in almond production. The PMA has proven to be a valuable platform from which the industry can educate such agencies as the Environmental Protection Agency, the State Water Resources Control Board and the regional Water Quality Control Boards on almond production practices and the importance of controlling pests and diseases.

The first year has not been without its bumps. Among the lessons learned in Year One:

- There needs to be a standardized reporting form for each regional project so that similar components are looked at and analyzed. The management team is committed to making improvements in this area in Year Two. Economic analysis cannot be emphasized enough.
- There probably needs to be additional pests and diseases considered at each of the regional plots. The management team will consider this as Year Two advances.
- No one can control the weather. Near perfect climatic conditions across all the plots made for an almost perfect growing season-- as evidenced by the record 830 million pound crop in the 1998-99 crop year. But, such perfect weather makes it difficult to analyze the various treatments and their effectiveness.
- A "no input" plot was suggested for the three regions. However, at this time, there has not been a grower-cooperator who has come forward and volunteered such a plot.
- Regional differences in growing almonds also means that outreach efforts need to be more targeted and specialized as the project moves forward in Year Two. "One size fits all" doesn't work any more for outreach efforts than it does for growing almonds. More targeted mailings are planned for Year Two.

Two lessons rise above all else in the final analysis of Year One:

1) Monitoring is key to the success of any pest control program. The University of California and the Almond Board of California has spent considerable funds on the study of pests and diseases. That information has no value if it is not implemented in a pest and disease-monitoring program. The grower needs to know what is going on in his orchard so he can make well informed, intelligent decisions on how to control diseases and pests.
2) Economic analysis is critical to the success of any reduced risk program. Growers are responsible stewards of the land but they need an economic incentive to keep on farming. Providing that economic information is key to any possible future adoption of reduced risk practices.

# APPENDICES

**APPENDIX #1**

**Stanislaus County Almond PMA Project**
**Year-end Summary 1999**

Walt Bentley, IPM Advisor, Kearney Agricultural Center, Parlier
Roger Duncan, UCCE Farm Advisor, Stanislaus County
Lonnie Hendricks, UCCE Farm Advisor, Merced County
Cara Cross, Field Technician, Stanislaus County UCCE
Merlyn Garber, grower
Art Bowman, pest control advisor

The Stanislaus County PMA site is a research trial as well as a demonstration. The trial is being conducted in a uniform 120-acre orchard (Nonpareil: Carmel) west of Modesto. Three insect pest management program treatments are fully replicated three times within the 120-acre orchard. Each plot is approximately 13.5 acres in size. The treatments are:

**Grower's Standard Practice:** This pest management program is fairly common in the Northern San Joaquin Valley. While most growers in this area apply a hull split spray for naval orangeworm control, our cooperator elects to target peach twig borer with a May spray. Specifically, pesticide treatments included:

- A dormant application (1-21-99) of Asana XL (a pyrethroid) @ 8 oz, Kocide DF @ 8 lb, and Gavicide Super 90 @ 6 gallons (6%)
- A May spray (5-20-99) of Lorsban 4E (an organophosphate) @ 4 pints + 12.8 oz Nu-film 17.
- Omite was applied to the northwest corner (approximately four acres) of Replication 1 on 7-12 due to an increase of Pacific mites (an area historically prone to mite buildup). On August 5 the entire replication (13 acres) was treated with Omite as mites were beginning to build and the cooperator was concerned about the 30-day pre-harvest interval.

**Intermediate Program:** In these areas, "reduced risk" pesticides are used. Specifically, pesticide treatments included:

- A dormant application (1-21-99) of Success @ 6.4 oz, Kocide DF @ 8 lb, and Gavicide Super 90 @ 5 gallons (5%)
- A May PTB spray (5-21-99) of Success @ 6.4 oz
- Agri-Mek 0.15 EC @ 10 oz & Gavicide Super 90 @ 1 gallon were included in the May spray because mite populations were beginning to build in Replication 1 only.

**Soft program:** Pesticide treatments included:

- A dormant application (1-21-99) with oil only (Gavicide Super 90 @ 6 gallons)
- Two bloom applications of Bt (Dipel DF @ 1.5 lb on 3-2 and 3-16). These coincided with normal fungicide applications and therefore did not necessitate additional application costs.
- Two May PTB sprays of Bt (Dipel DF @ 1.5 lb on 5-14 and 5-24)
- Agri-Mek 0.15 EC @ 10 oz & Gavicide Super 90 @ 1 gallon for Replication 1 only (5-24)

All dormant and in-season sprays were applied in approximately 100 gallons of water per acre. Mummies were removed and destroyed in all treatments. Mummy counts were recorded on February 12 & 15, 1999 and averaged 0.4 mummies per tree. There were no differences between treatments. Cover crop management (periodic mowing of native vegetation), fertilization, and fungicide treatments did not differ between treatments. A nutrient buffer product (10-12-0) was included in the May sprays for all treatments.

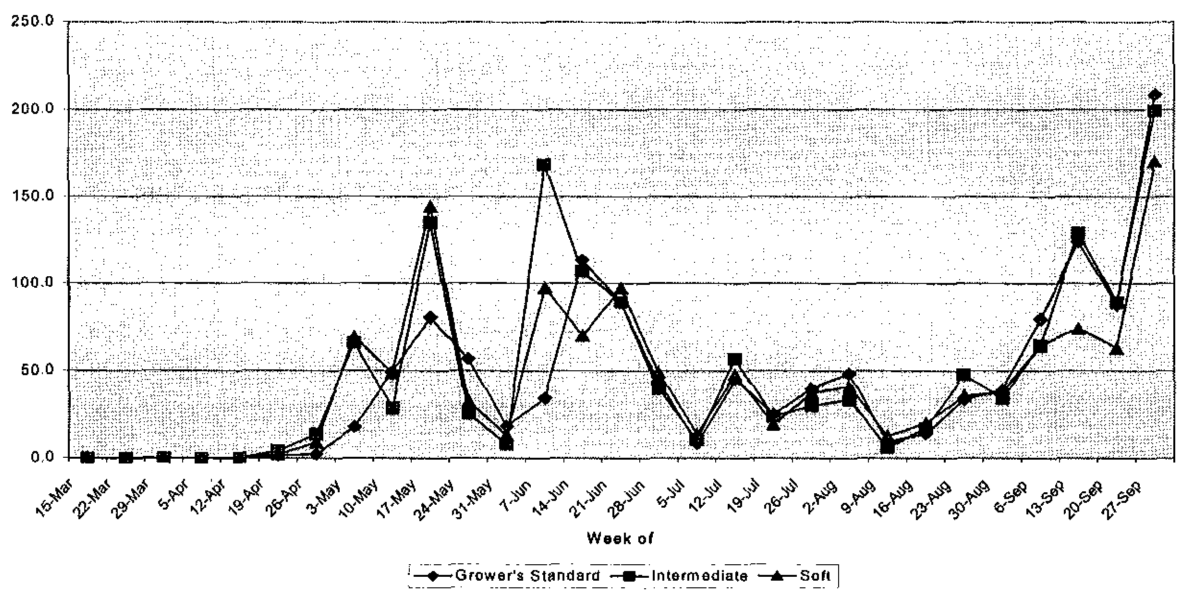
**Monitoring**

Peach twig borer hibernacula were examined in the spring to determine appropriate "bloom-time" Bt sprays for overwintering PTB. The first Bt application was made when approximately 20% of the overwintering PTB larvae had emerged. The second Bt application was applied at approximately 90% emergence. Both of these applications coincided with the normal bloom-time fungicide applications. PTB pheromone traps were hung March 29 and checked every other day to establish the first biofix. The first biofix for PTB was April 17.

In each treatment replication there were two PTB pheromone traps, two S.J. scale pheromone traps, four S.J. scale crawler sticky tape traps, and two NOW egg traps for a total of 90 traps in the trial. The orchard was monitored twice weekly through the season for PTB and NOW. Trap catches and the degree-day phenology model were used to determine application timings for the May PTB spray. San Jose scale pheromone and sticky tape traps were checked weekly. Each plot was also monitored weekly for mites using the presence / absence sampling technique. In addition, ants were monitored occasionally using the hot dog baiting method.

Figure 1 shows the seasonal dynamics of the peach twig borer flight in this trial. During the first half of the season there tended to be fewer peach twig borer in the Grower's Standard treatment. There did not appear to be differences between the intermediate and soft programs.

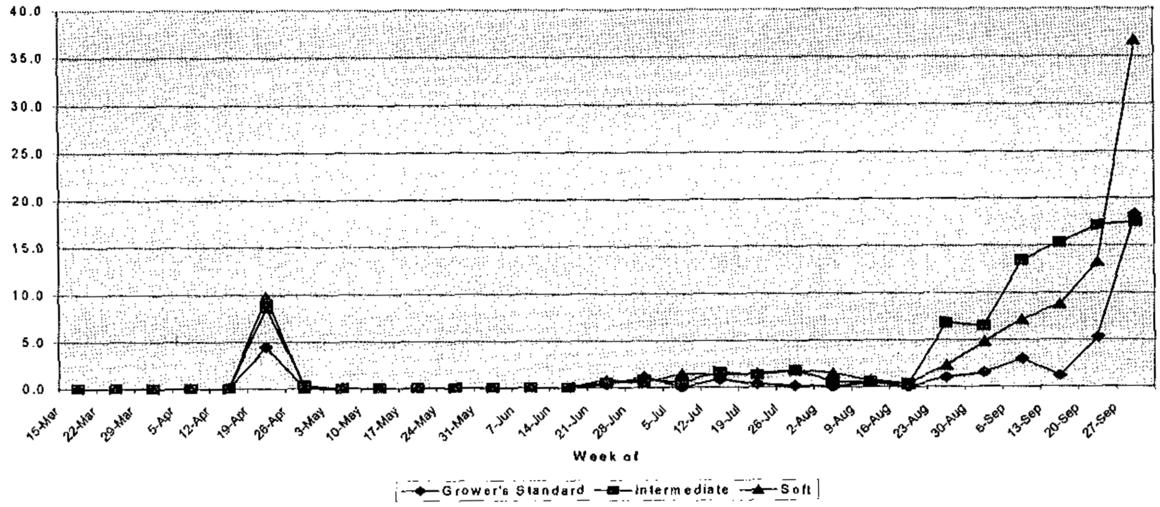
**Figure 1. Average number of Moths per Trap per Week**
**Peach Twig Borer 1999**




After June 21, PTB flights appeared very similar for all three-pest management programs.

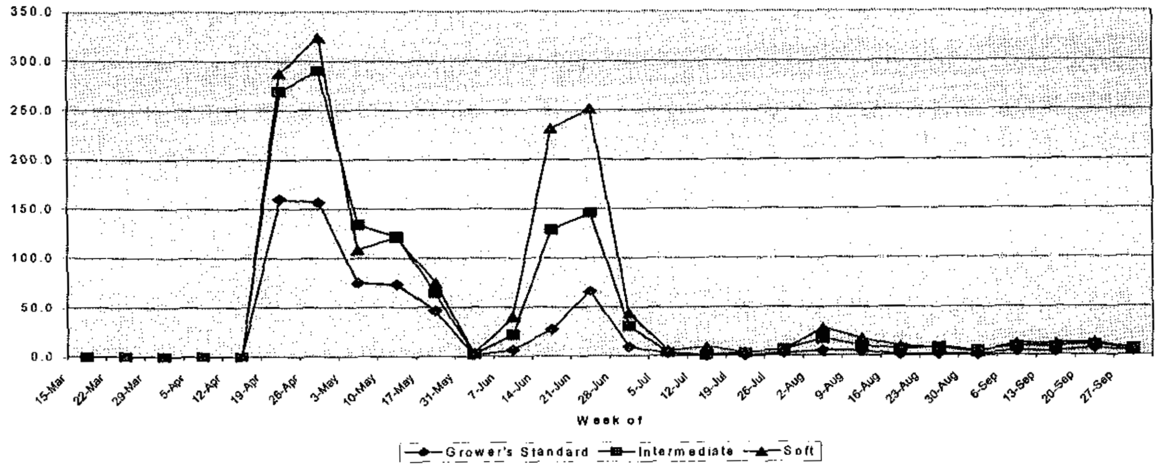
Flights of San Jose scale were very low through most of the season in all pest management programs. By the first of September, male scale catches increased substantially. Trap catches were lowest in the Grower's Standard treatment. Seasonal population dynamics for the San Jose scale flight are shown in Figure 2.

Figure 2. Average Number of Males per Trap per Week
San Jose Scale 1999




Dynamics of the Encarsia (Prospaltella) flight are shown in Figure 3 below. We began catching Encarsia in mid-April and continued catching high numbers through June. Peak populations reached approximately 300 Encarsia per week in the soft and intermediate pest management programs. Parasite populations were substantially lower in the Grower's Standard treatment.

Figure 3. Average per Trap per Week
Prospaltella 1999



**Naval Orangeworm**

Naval orangeworm egg laying was detected very infrequently on our eighteen almond press-cake egg traps. No egg laying was detected through the whole year in the soft and intermediate pest management blocks. Only thirty eggs were detected in the Grower's Standard treatment, and these occurred during the first two weeks of sampling.

Cumulative trap catches through June 15 for PTB, SJ. scale males (pheromone traps), Encarsia, Aphytis and naval orangeworm are listed below for the three treatments.

| | **Table 1. Average cumulative number of Arthropods per trap through June 15, 1999** | | | | |
|---|---|---|---|---|---|
| | **PTB** | **S.J. Scale** | **Encarsia** | **Aphytis** | **NOW** |
| Standard | 1876 | 27 | 3287 | 15 | 30 |
| Intermediate | 3066 | 54 | 6207 | 16 | 0 |
| Soft | 2117 | 59 | 7150 | 30 | 0 |

The first half of the season, there were fewer PTB caught in the Grower's Standard treatment and most in the intermediate treatment. By the end of the season, there were no significant differences in peach twig borer catches between the grower's standard treatment and the two softer programs. However, the trend of fewer San Jose scale and scale parasites continued throughout the season.

Cumulative trap catches through September 30 for PTB, S. J. scale males (pheromone traps), Encarsia, Aphytis and naval orangeworm are listed below for the three treatments

| | **Table 2. Average cumulative number of Arthropods per trap through September 30, 1999** | | | | |
|---|---|---|---|---|---|
| | **PTB** | **S.J. Scale** | **Encarsia** | **Aphytis** | **NOW** |
| Standard | 7641 | 229 | 3976 | 166 | 30 |
| Intermediate | 8588 | 480 | 7854 | 188 | 0 |
| Soft | 7652 | 558 | 9728 | 188 | 0 |

**Mites**

The trial was sampled weekly for mites using the presence / absence sampling technique. Fifteen leaves each from three trees per plot were examined for presence of mites and mite predators. Numbers were compared to the chart in the University of California Almond IPM Manual to determine if mite treatments were necessary. In two of the three blocks (both irrigated with microsprinklers), mites never reached treatable levels according to our sampling technique. However, the grower grew concerned about increasing mite numbers on orchard edges and decided to treat these areas with ten pounds of potassium nitrate plus 2% oil on August 28. The higher mite numbers along orchard edges did not appear to be related to pest management treatments.

In the northern-most 40-acre block (Replication 1), Pacific mite numbers began building and exceeded threshold values by mid-May. As a result, Agri-Mek (avermectin) was included in the May PTB spray in replication 1 of the soft and intermediate programs. The Grower's Standard treatment was not treated at this time because it was felt Omite could be applied later effectively if mite numbers continued to increase. Omite was eventually applied on July 12 to the edge of the Grower's Standard treatment in replication 1 and finally to the entire plot on August 6. Mite counts remained very low in avermectin treated areas through the remainder of the season.

**Ants**
Ant populations were monitored on July 29. Fifteen vials containing a 3-5 cm section of hotdog were placed throughout each plot. After three hours the vials were collected, taken back to the lab and frozen. Ants in each vial were counted. Ant populations were very low and were not at treatable levels. Ant counts for the three treatments are shown in Table 3 below.

| Table 3. Average Number Of Ants Per Vial Using The Hot Dog Baiting Technique. Stanislaus County Almond PMA trial, 1999. | | |
|---|---|---|
| **Treatment** | **Mean Number Of Ants Per Vial** | |
| | **Fire Ant** | **Pavement Ant** |
| Grower's Standard | 0.1 | 0.5 |
| Intermediate | 0.1 | 0.9 |
| Soft | 0 | 14.7 |

**Harvest**
At harvest, nuts were collected randomly from windrows in all plots. Five hundred Nonpareil kernels will be examined from each plot (1,500 total per treatment) for presence or feeding damage from peach twig borer, naval orangeworm, and ants. As of the date of this report only 200 kernels per treatment have been examined.

As shown in Table 4, preliminary data show damage from all three insect pests was very low in all treatments. No statistical analyses have been performed on these data as yet.

| Table 4. Percent Rejects of Harvested Nonpareil Almonds Farmed Under Three Pest Management Programs. Stanislaus County Almond PMA Trial, 1999 | | | | | | |
|---|---|---|---|---|---|---|
| **Treatment** | **% NOW** | **%PTB** | **% Ant** | **Shriveled** | **% NOW between hull & shell** | **% PTB between hull & shell** |
| Standard | 0.3 | 0 | 0.2 | 3.2 | 0.3 | 0 |
| Interm | 0.5 | 0 | 0 | 2.3 | 1.2 | 0.2 |
| Soft | 0 | 0 | 0.2 | 2.2 | 0.3 | 0 |

**Treatment Costs**
Costs associated with each pest management program are itemized below. Material costs reflect actual prices at the date of purchase from a local agricultural chemical supplier. Application costs reflect the price of labor to mix, load and apply materials, (including wages, workman's compensation, insurance, etc.), fuel costs, and equipment maintenance as calculated by the grower.

| Costs Associated with Three Pest Management Programs. Stanislaus County Almond PMA Trial, 1999 | | |
|---|---|---|
| **TREATMENT** | **APPLICATION** | **COST PER ACRE** |
| **Grower's Practice (RED)** | **Dormant Spray (1-21-99)** | |
| | Asana XL @ 8 oz | $9.52 |
| | Kocide DF @ 8 lb | $18.22 |
| | Gavicide Super 90 @ 6 gal | $16.43 |
| | Application costs: | $13.65 |
| | Subtotal: | **$57.82** |
| | **May Spray (5-20-99)** | |
| | Lorsban 4E @ 4 pints | $23.94 |
| | Nu-Film 17 @ 12.8 oz | $3.39 |
| | Application costs: | $13.65 |
| | Subtotal: | **$41.42** |
| | **Mite spot treatment spray (7-12-99)** | |
| | Omite 6E @ 3 pints on only 4 acres | $4.28 |
| | Nu-Film P @ 6 oz. on 4 acres | $0.37 |
| | Application costs on 4 acres | $1.37 |
| | Subtotal: | **$6.02** |
| | **Mite Spray – Replication 1 only (8-6-99)** | |
| | Omite 6E @ 3 pints on only 13.5 acres | $14.25 |
| | Nu-Film 17 @ 12.8 oz. on 13.5 acres | $1.13 |
| | Application costs on 13.5 acres | $4.55 |
| | Subtotal: | **$19.93** |
| | **TOTAL COST OF GROWER'S PRACTICE PESTICIDE PROGRAM** | **$125.19** |
| **Intermediate (WHITE)** | **Dormant Spray (1-21-99)** | |
| | Success @ 6.4 oz | $38.25 |
| | Kocide DF @ 8 lb | $18.22 |
| | Gavicide Super 90 @ 5 gal | $13.69 |
| | Application costs | $13.65 |
| | Subtotal | **$83.81** |
| | **May Spray (5-21-99)** | |
| | Success @ 6.4 oz | $37.68 |
| | Application costs | $13.65 |
| | Subtotal | **$51.33** |
| | **Mite Spray – Replication 1 only (5-21-99)** | |
| | Agri-Mek 0.15EC @ 10.0 oz | $21.90 |
| | Gavicide Super 90 @ 1 gal | $0.91 |
| | Application costs (piggy back w/ May spray) | 0.00 |
| | Subtotal | **$22.81** |
| | **TOTAL COST OF INTERMEDIATE PESTICIDE PROGRAM** | **$157.95** |

| TREATMENT | APPLICATION | COST PER ACRE |
|---|---|---|
| **Soft** | **Dormant Spray (1-21-99)** | |
| **(BLUE)** | Gavicide Super 90 @ 6 gal | $16.43 |
| | Application costs | $13.65 |
| | Subtotal | **$30.08** |
| | **Bloom-time PTB Sprays (piggy-back w/** | |
| | **fungicides)** | $16.05 |
| | Dipel DF @ 1.5 lb (5-14-99) | $0.00 |
| | Application costs | $16.05 |
| | Dipel DF @ 1.5 lb (5-24-99) | $0.00 |
| | Application costs | **$32.10** |
| | Subtotal | |
| | **May PTB Sprays** | |
| | Dipel DF @ 1.5 lb (5-14-99) | $16.05 |
| | Application costs | $13.65 |
| | Dipel DF @ 1.5 lb (5-24-99) | $15.88 |
| | Application costs | $13.65 |
| | Subtotal | **$59.23** |
| | **Mite Spray - One block only (5-24-99)** | |
| | Agri-Mek 0.15EC @ 10.0 oz | $21.90 |
| | Gavicide Super 90 @ 1 gal | $0.91 |
| | Application costs (piggy back w/ May spray) | 0.00 |
| | Subtotal | **$22.81** |
| | **TOTAL COST OF SOFT PESTICIDE PROGRAM** | **$144.22** |

**DISCUSSION**

In general, pest populations and reject levels were similar and very acceptable for all three-pest management programs this season. A pattern of reduced arthropod numbers (both pest and beneficial) was established in the Grower's Standard treatment. However, pest pressure was generally low in all treatments and the low levels of damage at harvest reflected this. Over time, differences in pest and beneficial arthropod populations between treatments may become larger. It is uncertain whether reduced kill of San Jose scale in the softer treatments will lead to economically damaging levels or whether the increased numbers of scale parasites will keep this pest under control. More significant differences in other pest populations may also become apparent with time.

Costs to the grower were 15% and 26% higher than the grower's standard treatment in the "soft" and intermediate programs, respectively. Higher costs in the "soft" program are associated with an extra in-season application for PTB control and the use of a more costly miticide. In the future, a cheaper "reduced risk" miticide may be used in this treatment. Increased costs in the intermediate program were associated with the use of Success and Agri-Mek, two relatively expensive materials.

Risk of increased losses due to higher reject levels and increased San Jose scale are arguably higher in the "soft" and intermediate programs. Increased costs of extra monitoring in softer pest management programs should be included in an analysis of these programs also.

One must be careful not to put too much emphasis on the preliminary results of this trial. It may take a few years before significant shifts in arthropod populations occur. This trial is conducted in an orchard with historically low reject levels in a year with unusually low pest pressure. It will be interesting to observe this trial over the next few years.

In the future, treatments may be modified slightly but the general idea of maintaining "standard", "intermediate", and "soft" management strategies will continue. It would be interesting to include a completely unsprayed or "oil only" treatment.

**APPENDIX #2**

**Pest Management Alliance Project**
**Kern County**

Mario Viveros, Walt Bentley, Peggy Schrader and Marjie Bartels

## INTRODUCTION

The purpose of this project was to demonstrate a reduced pesticide input versus a conventional pesticide program in almond orchards. (See Appendix A for comparison). The site was ideal. There were two 40-acre blocks of hard shell varieties (Butte, Mission, and Padre), and two 40-acre blocks of soft shells (Nonpareil, Sonora, and Fritz). Each 40-acre block was divided into reduced input and conventional blocks. The demonstration was started in November 1998 with the planting of a cover crop and has continued until the present time.

### Cover Crop

Barley was selected as the cover crop because of the saline-alkali and poor drainage condition of the soil. The barley was seeded in every middle on both soft and hard shell blocks at a rate of 40 lbs. per acre. This was done in late November. At this time, an insectary was established on every 11th middle using the 1998 BIOS Insectary Mixî (See Appendix B for mixture composition). The rate of seeding was 10 lbs. per acre.

The barley germinated well and created a solid cover. It did improve the drainage of the soil and provided a cool environment. The insectary mix didn't do that well. The clovers, rye, vetch, coriander and celery didn't germinate at all, and a limited number of toothpick weed and yarrow plants were present in the middles.

### Pest Monitoring

Trapping for three key pests of almonds was done throughout the season. Traps were hung together on the same tree, seven trees in from the end of the row in Nonpareil and Mission varieties. Three San Jose Scale sticky traps were placed per block, six to seven feet high in the northeast quadrant of the tree on February 22, 1999, and were monitored weekly until the end of November. Pheromone lures were replaced every four weeks. Adult San Jose Scale moths were counted, as well as the *Prospaltella* and *Aphytis* adults. Double-sided sticky tapes were placed one per tree in each of the four trees surrounding the ìtrap trees on April 15, 1999, and were collected and replaced every other week through November. The number of San Jose Scale crawlers per tape were then counted and recorded. Two peach twig borer traps were placed per block, six to seven feet high in the northeast quadrant of the tree on March 22, 1999; adult moths were counted weekly until the end of November. Pheromone lures were replaced every eight weeks. Two navel orangeworm traps per block containing an almond meal mixture were placed six to seven feet high in the north side of the tree on March 29,1999; eggs laid on the exterior grooves of the trap were counted weekly through the end of November. Bait was replaced every eight to ten weeks.

**Dormant Spray**

The dormant spray was done in the conventional blocks on January 4, 1999. It consisted of five pts of Diazinon and six gallons of oil in 200 gallons of water per acre. The reduced pesticide input was left unsprayed. The dormant spray treatment gave us mixed results for key pests in almonds. Table 1 shows that PTB emergence was not affected by the dormant spray. One can also say that dormant spray didn't completely eliminate the PTB in the orchard.

Graph 1 shows that dormant sprays had little or no effect on the number of strikes in both reduced input, and conventional spray programs. Furthermore, Graph 2 shows that the dormant spray did not affect the PTB adult population. One possible explanation may be due to the fact that the PTB traps were pulling adult moths from the neighbor's orchard or from the unsprayed adjacent blocks.

**Graph 1. The average number of strikes per tree on April 19 and June 30 in both reduced input and conventional spray programs.**

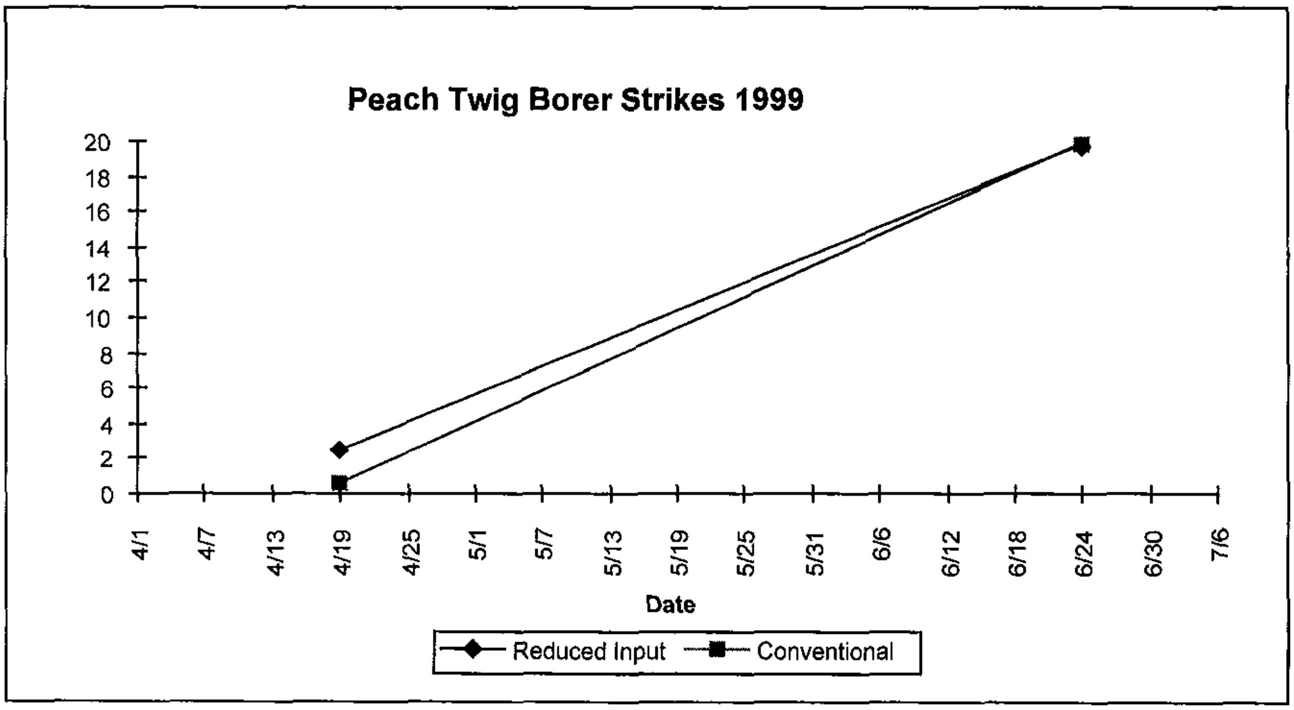
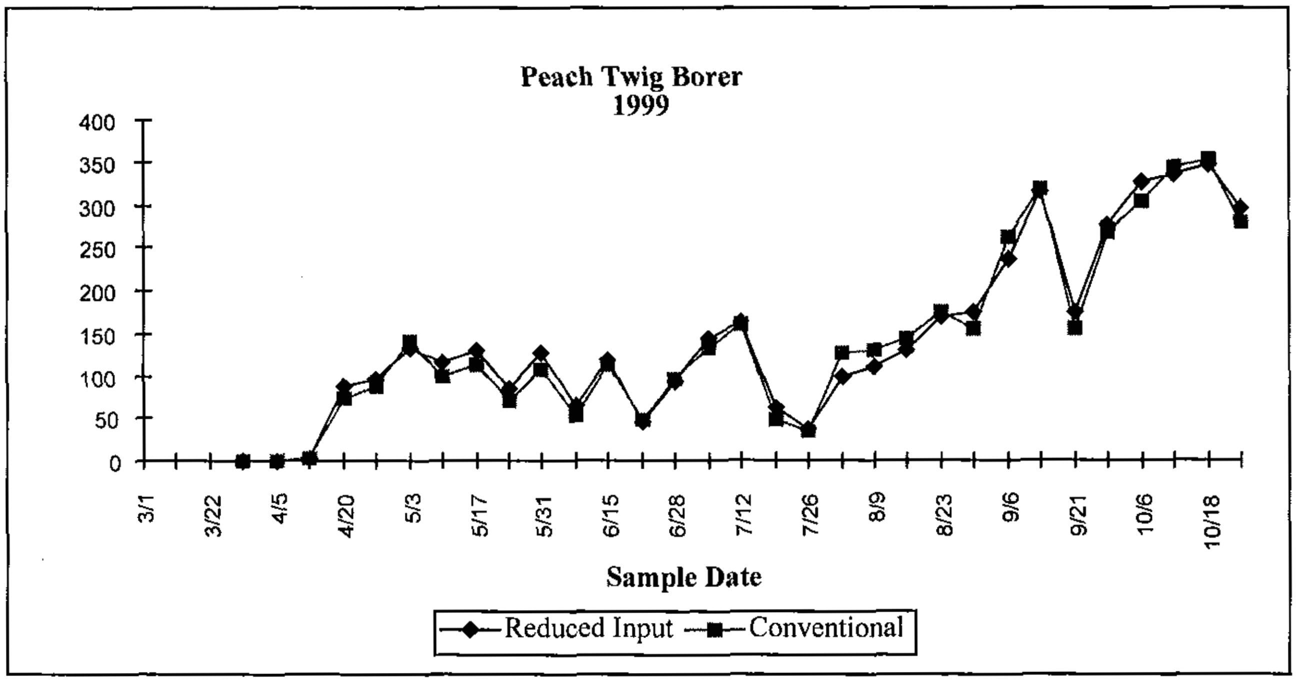


**Table 1. Percent of PTB emergence from samples taken at different dates from reduced input and conventional treated blocks.**

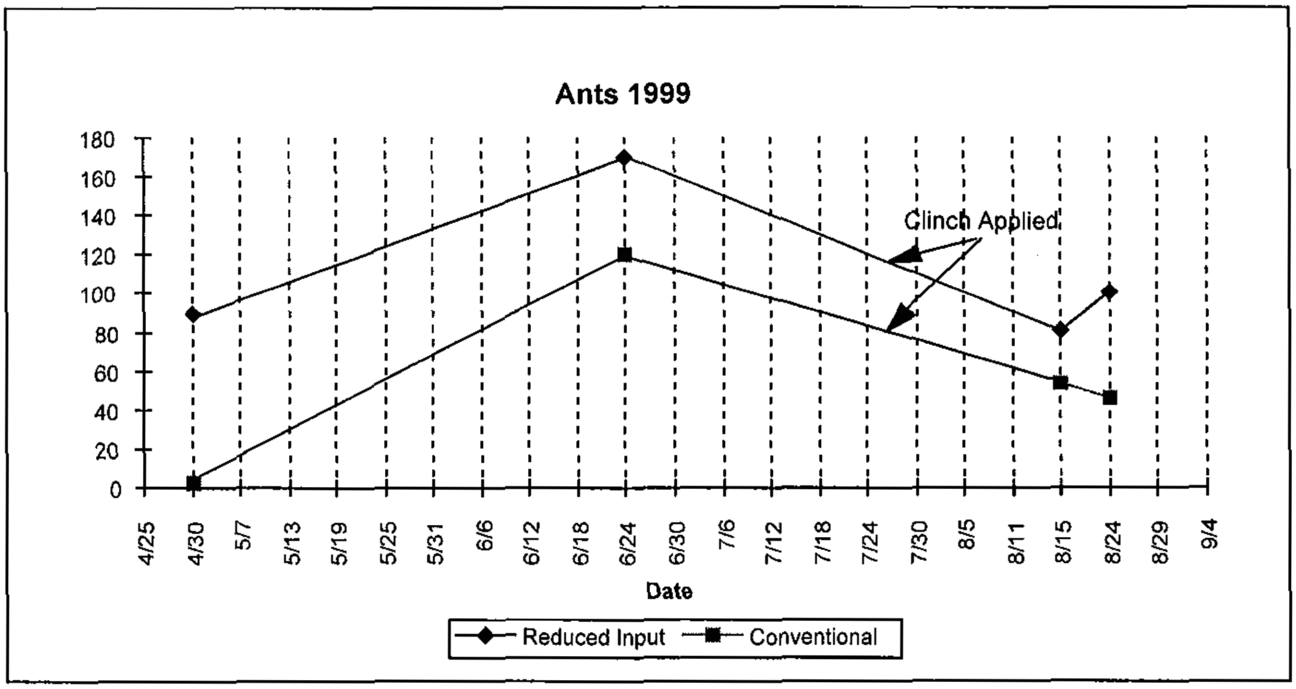
| Date | Reduced Input | Conventional | Overall |
|---|---|---|---|
| February 15 | 15% | 9% | 12% |
| February 19 | 18% | 27% | 22% |
| February 26 | 23% | 24% | 23% |
| March 5 | 50% | 55% | 52% |
| March 12 | 77% | 75% | 76% |
| March 19 | 85% | 88% | 86% |

**Graph 2. The average number of PTB adults per trap during the 1999 season in both reduced input and conventional spray programs.**



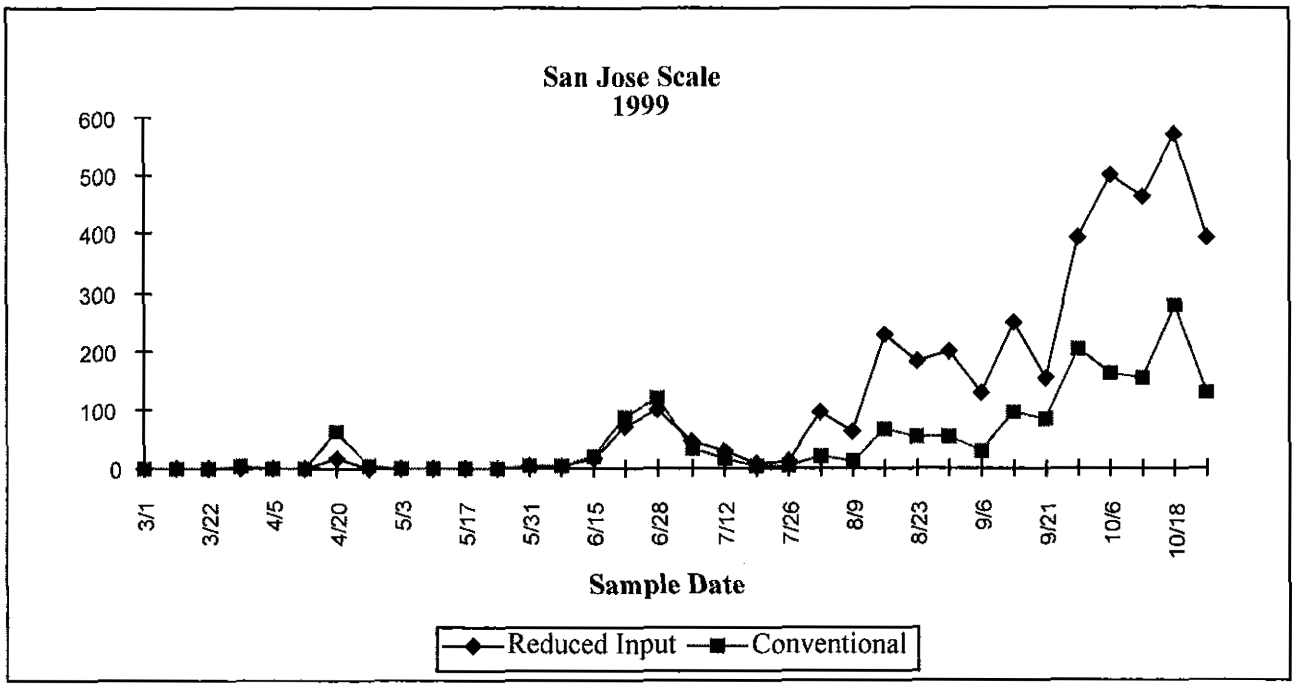
The dormant spray may have affected the ant and San Jose Scale (SJS) populations. Graph 3 shows a higher number of ants per vial in the reduced input than on the conventional. This difference remained constant throughout the season.

**Graph 3. Average number of ants per vial on both reduced input and conventional blocks from four different sampling dates.**



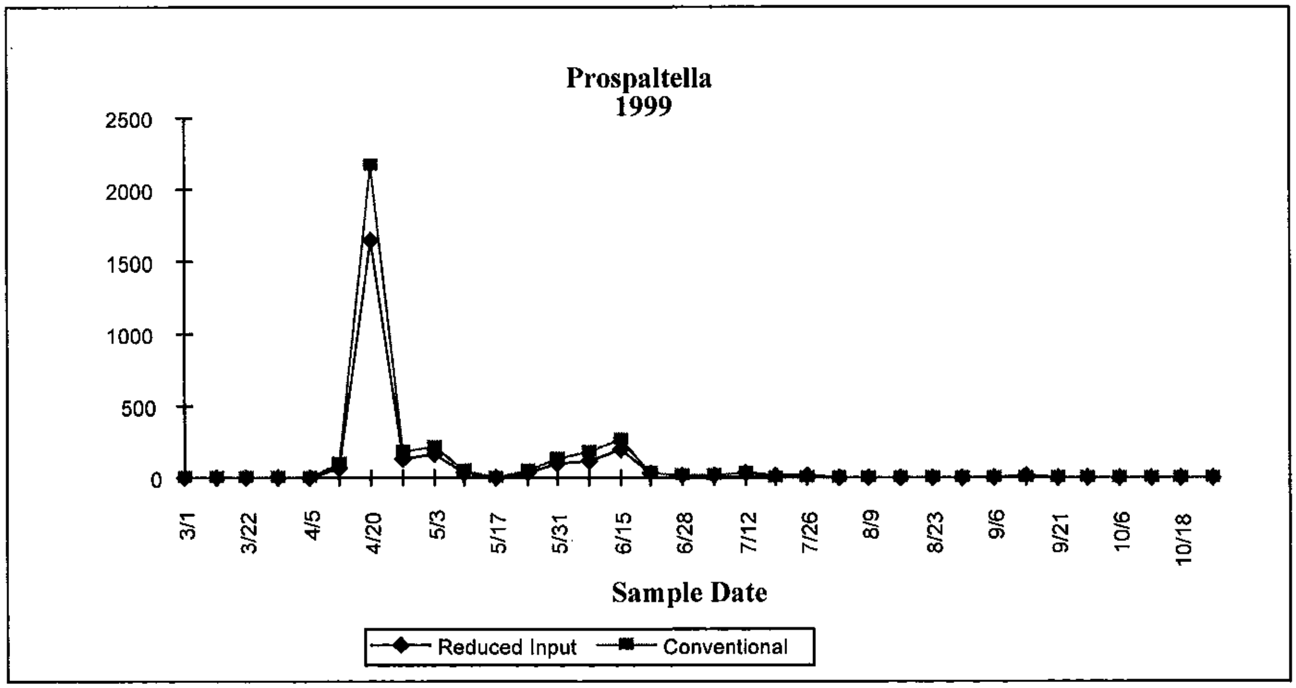
Graph 4 shows that the SJS population from March 1st to October 25th is the same in both reduced input and conventional; however, by August 3rd, the reduced input shows a higher SJS population than the conventional. This high population continues to be higher than the conventional until the last reading on October 25th. An ImidanÆ (5.3 lbs. 70W per acre) spray was applied to every other middle on July 10th. This spray didn't show any effectiveness on SJS, since it was applied after the SJS population had peaked on June 28th. However, both dormant and ImidanÆ sprays may be responsible for maintaining a lower SJS population in the conventional blocks.

**Graph 4. Average number of SJS adults per trap from March 1 to October 25, 1999 from both reduced input and conventional spray programs.**

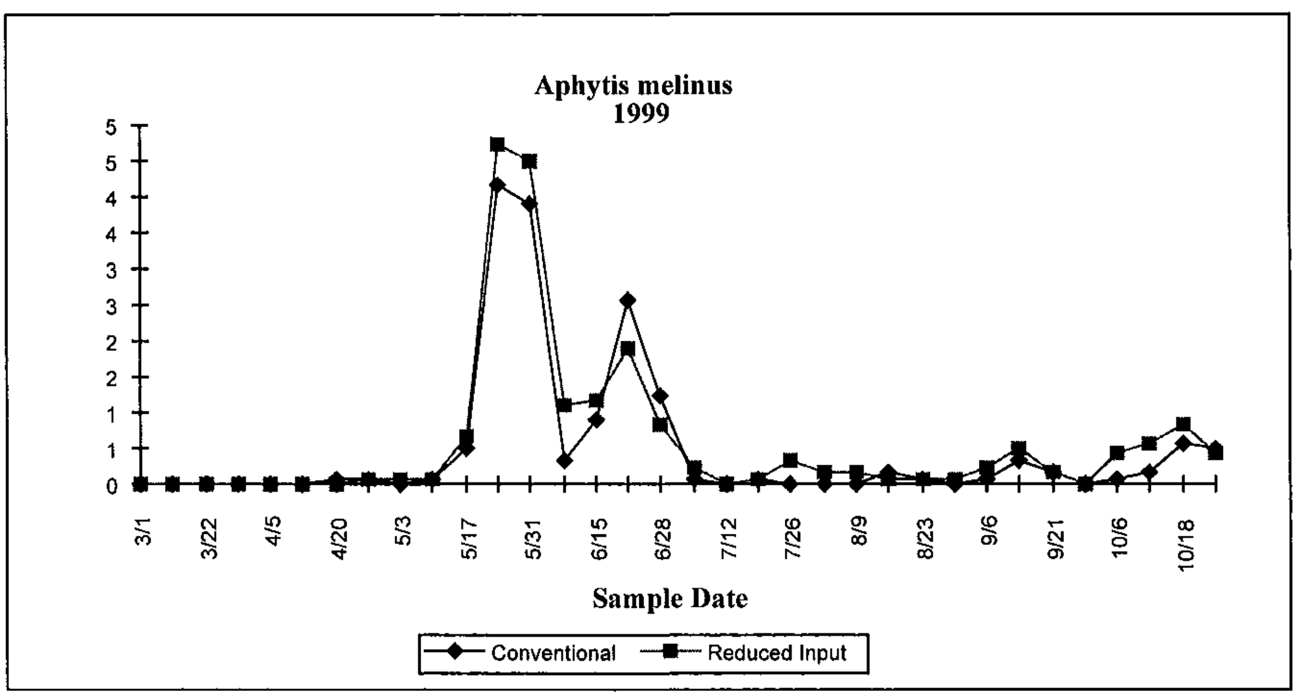


Graphs 5 and 6 show the parasite populations for both reduced input and conventional spray programs. Both *Prospaltella* and *Aphytis* have the same population in both conventional and reduced input spray program; therefore, they don't account for the difference in SJS population at the end of the season.

**Graph 5. Average number of *Prospaltella* per trap from March 1st to October 25th in both reduced input and conventional spray programs.**




**Graph 6. Average number of *Aphytis* per trap from March 1st to October 25th in both reduced input and conventional spray programs.**

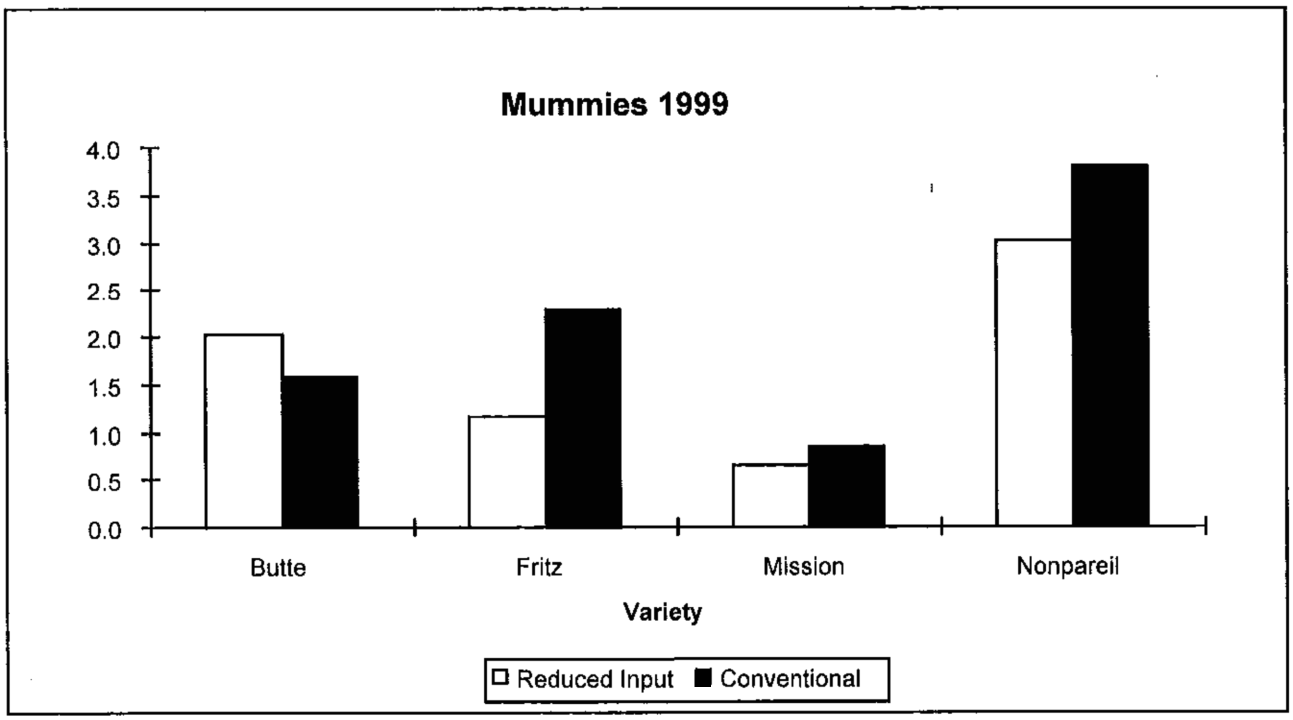


**Winter Sanitation**
Mummy removal (the elimination of last year's remaining nuts) or sanitation has been a very important tool for the control of navel orangeworm in the Southern San Joaquin Valley. Orchard sanitation was done in the reduced input in January. Then, a few days later, it was evaluated in both reduced input and conventional blocks.

Five percent of trees per row of Nonpareil, Fritz, Butte, and Mission varieties were surveyed. After walking in one or two trees, every 18th tree was selected for a total of four trees per row; total mummies per tree were counted, including sticktights and mummies that had been cleaned out by birds.

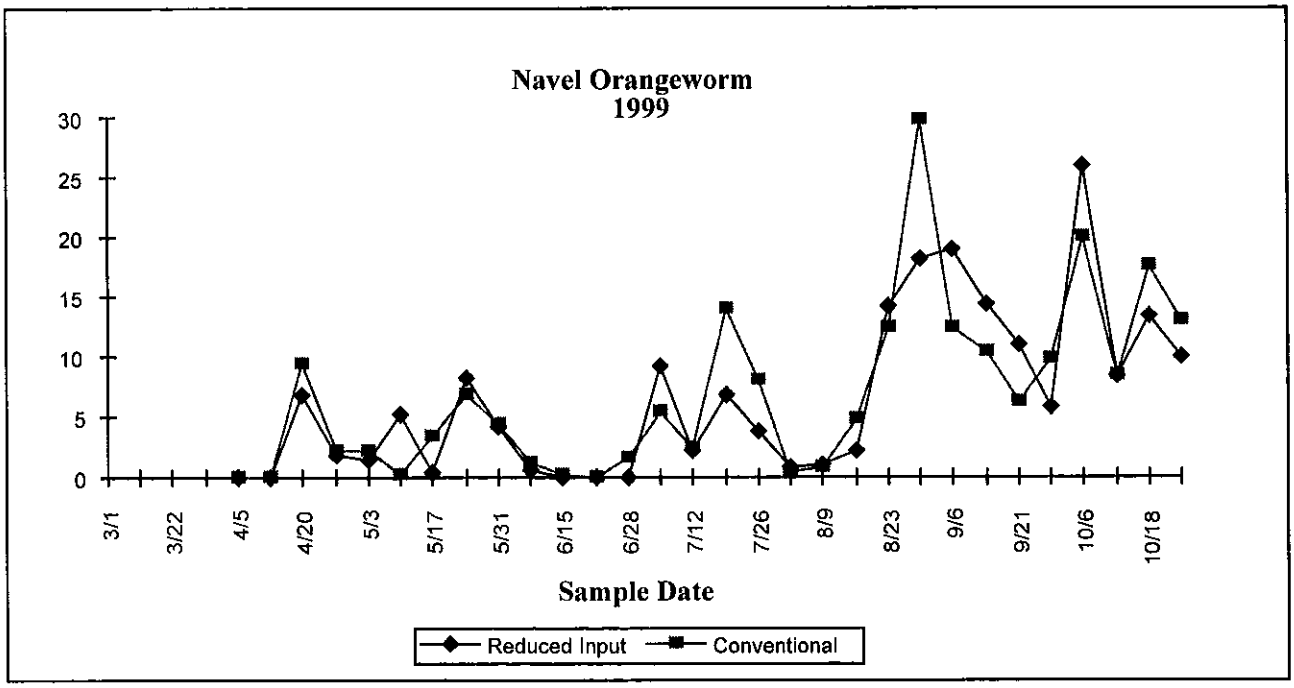
Graph 7 shows the results of this evaluation. There were fewer mummies per tree in the Butte variety in the conventional than on the reduced input. However, there were more mummies in Fritz, Mission and Nonpareil varieties in the conventional than on the reduced input. Unfortunately, both reduced input and conventional blocks had more mummies than is recommended in the IPM manual. The recommendation is two mummies per tree.

**Graph 7. Average number of mummies per tree in Butte, Fritz, Mission, and Nonpareil varieties from the reduced input and conventional blocks.**



Graph 8 shows the average number of NOW eggs per trap from April 5th to October 25th for both conventional and reduced blocks. In the overwintering generation, the number of eggs per trap is slightly higher in the reduced input than on the conventional blocks. However, this situation drastically changes in the second and third generation, where the average number of eggs per trap is significantly higher in the conventional than in the reduced. I don't believe SuccessÆ at 6 oz. per acre or ImidanÆ at 5 lbs. per acre (applied July 10) had any effect on the control of NOW. It's possible, however that the organophosphate in the dormant and in season spray may have affected the NOW predators in the conventional blocks.

**Graph 8. Average number of NOW eggs per trap from April 5th, to October 25th, in the reduced input and conventional spray program.**




## Bloom

Bloom is a very susceptible disease period in almonds. During bloom, almonds are susceptible to Blossom rot, Brown rot, Green fruit rot and Shothole disease. All these diseases require moisture to become a problem. Therefore, if one can predict rain or fog, we will be able to predict diseases. It is a common practice to apply two fungicide sprays, one at the onset of bloom and another at full bloom. These two sprays provide adequate protection to almond orchards in most years. The PMA orchard was sprayed with RovralÆ, a fungicide, at the onset of bloom. The rate was one pound per acre every other middle on the Sonora variety. This spray provided enough protection for disease control. The reason being that the orchard was on its 4th leaf and no major rains occurred during bloom.

**Peach Twig Borer Emergence**

Peach twig borer or PTB is a key pest in almonds. In some years, it can be more damaging than NOW. In the future, growers may not be able to use organophosphate (OP) sprays for its control. At the present time, however, there is an alternative for OP. The alternative is *Bacillus thuringiensis* or Bt. For Bt sprays to be effective, one needs to determine PTB emergence, or when the PTB larva leaves the hibernacula.

The PTB emergence curve was determined in the PMA orchard. Rust-colored hibernaculae (minute, chimney-like piles of grass and sawdust) were located in crotches of trees. With a grafting knife, a pie-shaped wedge containing the hibernacula was cut from the bark and placed into a vial. Ten samples were collected per block. Under the microscope in the lab, the hibernacula was opened with a probe and the larva (if present) was exposed in its ìcaveî under the bark. Emergence was calculated based on number of worms absent. The sampling began in early February and continued on a weekly basis until mid-March. Table 2 shows the data from this study.

**Table 2. Percent of PTB emergence and percent of bloom on Nonpareil at different dates from both conventional and reduced input spray programs.**

| Date | Reduced Input | Conventional | Bloom |
|---|---|---|---|
| 02-15-99 | 15% | 9% | 0% |
| 02-19-99 | 18% | 27% | 5% |
| 02-26-99 | 25% | 24% | 30% |
| 03-05-99 | 50% | 55% | 100% |
| 03-12-99 | 77% | 75% | -0- |
| 03-19-99 | 85% | 88% | -0- |

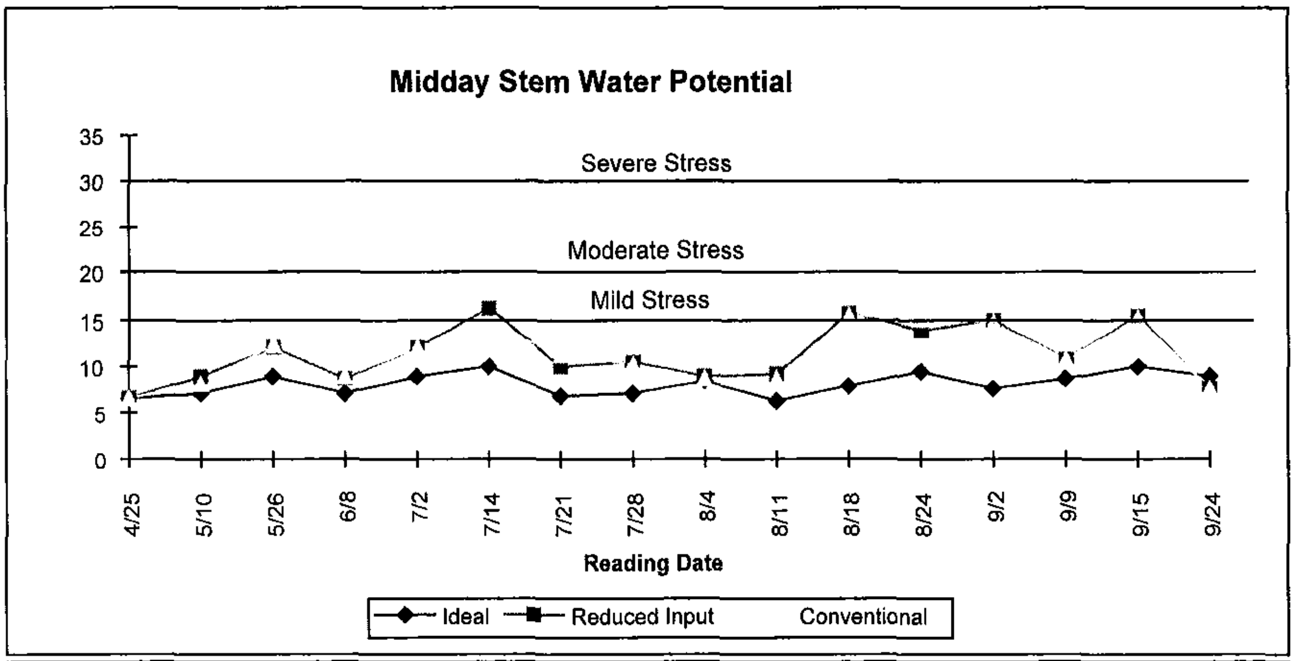
The data from the above table shows that PTB emergence begins before the Nonpareil bloom and the rate of emergence is slower than the rate of bloom development. This data also shows that Bt may or may not be effective in controlling PTB, when combined with a bloom spray. If a Bt is combined with the first bloom spray (5% bloom), the control of PTB will be minimum, because the percent of PTB emergence is low. However, the second bloom spray (100% bloom) will be more effective since 55% of the worms have emerged from the hibernacula. One Bt spray is not enough for the control of PTB. One needs three sprays; one at 40-50%, a second one at 70-80%, and a third at 80 to 100% emergence. Bt combined with a bloom spray will not give us proper control of PTB. To properly time Bt spray, an emergence curve needs to be developed for an orchard in one's area.

**Irrigation Monitoring**

Beginning on July 2, 1999, and continuing until September 15, 1999, pressure bomb readings were taken on a weekly basis. Prior to this, several readings were taken while the grower was establishing an irrigation schedule. Readings were taken on two trees in each 20-acre block. One tree was located on the north side of the block, the other on the south. In both cases, this was the third tree in from the road. In the morning, a small plastic-lined foil bag was used to cover a lower canopy leaf that was close to the trunk or main scaffold. Measuring took place at midday, usually about 1:00 p.m., when evaporative demand was at its peak. The leaf was removed from the tree and the end of the petiole cut with a razor so it had a uniform flat surface to view with a hand lens. The leaf was placed in the chamber with a small amount of petiole exposed. Raising the pressure in the chamber until water begins to come out of the xylem makes measurements.

By knowing the temperature and relative humidity when the readings were taken, it can be determined what values to expect for a fully irrigated almond orchard. Graph 9 shows that the trees in both reduced input and conventional programs were adequately irrigated. Their midday stem water potential was kept around and under the mild stress level, but above the ideal stem water potential levels.

**Graph 9. Mid-day stem water potential of trees in reduced input and conventional blocks and the ideal mid-day water potential have well irrigated trees.**



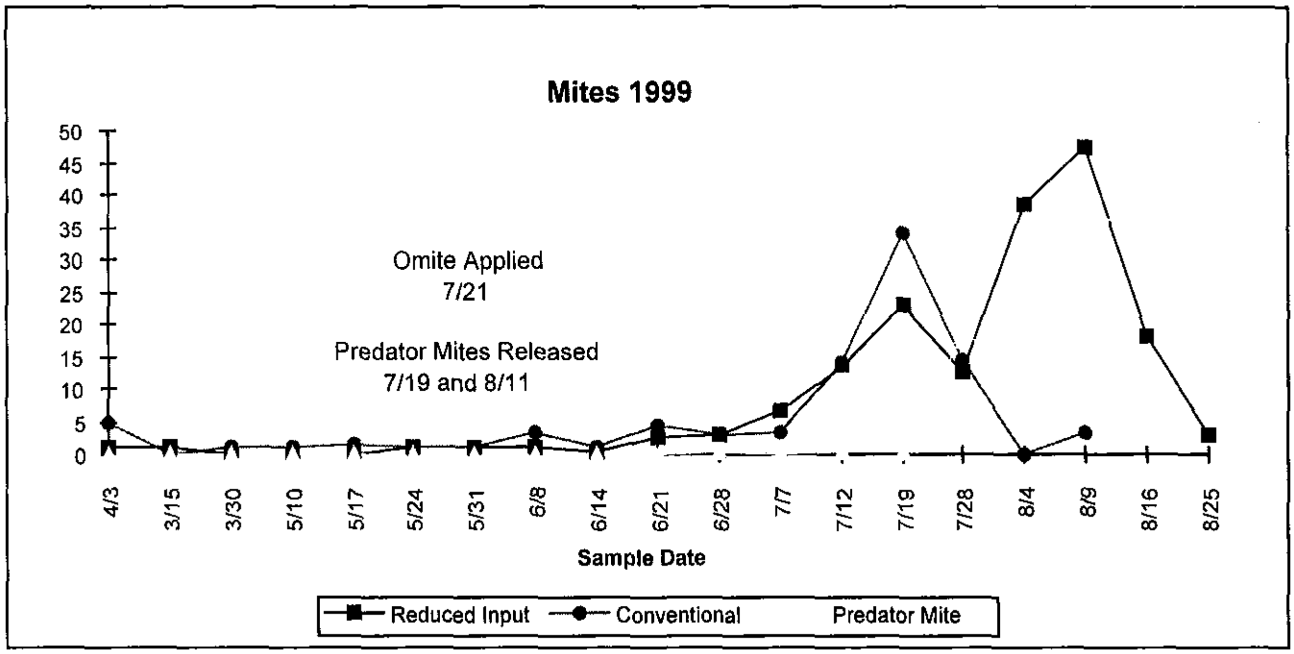
**Mite Management**
Mites are the most difficult and most expensive pests to manage in the Southern San Joaquin Valley almond orchards.

Mites were monitored in Nonpareil and Butte varieties in the PMA orchard every other week from mid-April to mid-May, then weekly until the end of August. Both conventional and reduced input blocks were checked until mid-August, when only the reduced input blocks were monitored. Five trees per block were selected at random from the south and north ends of the plot one week, then along the center road the next week. Five leaves per tree, mostly from the lower interior portion of the tree, were examined initially; when weekly monitoring began in mid-May, ten leaves per tree were checked, half from the interior and half from the exterior of the tree. Leaves were pulled at approximately head height from all around the tree and both upper and lower leaf surfaces were examined with a hand lens for webspinning spider mites (adults, immatures, and eggs); predatory mites (adults and eggs); and sixspotted thrips. The presence/absence method of counting was used, indicating the number of leaves out of five or ten leaves where mites were seen, not the actual number of mites. Also noted were presence of European red mite, lacewing eggs and larvae, substantial webbing or multiple mites on leaves, and any other information of interest.

Our approach to this pest was to keep the PMA orchard well watered, use well-timed OmiteÆ sprays in the conventional block and to release predator mites in the reduced input blocks. This approach was successful. It kept the mites under control in both reduced input and conventional blocks.
Mites in the Southern San Joaquin Valley were not a serious problem this year. Traditionally speaking, one can face a big mite problem by the first week in June.

Graph 10 shows that mites didn't appear in the PMA orchard until July 7th. The mite population did increase to a treatable level by July 19th. The conventional blocks were treated with 12 pts. of OmiteÆ per acre every other middle. The OmiteÆ treatment was very effective. The mite population was under complete control by August 4th. The predator mites were not released in the reduced input blocks until the webspinning mites population increased to a food supply level. This level was reached on July 19th. At this time, 2,500 predatory mites per acre were released in the reduced input blocks. At the beginning, this release didn't appear to control the webspinning mite infestation. For this reason, another 2,500 predatory mites per acre were released August 11th. After the second release, Graph 10 shows that the population of the webspinning mites started to decrease.

**Graph 10. Percent of leaves infested with web spinning and predatory mites during the season in both reduced and conventional spray programs.**



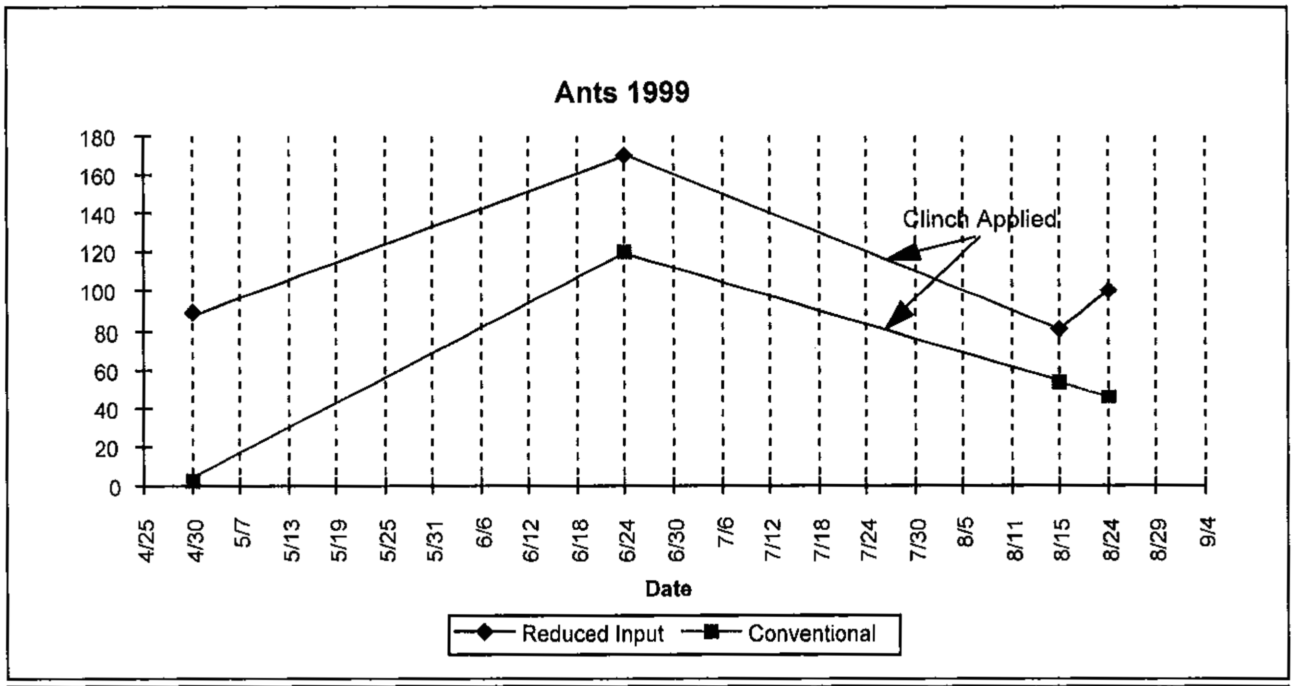

## Ant Management

Ants can cause more damage in almond orchards than NOW and/or PTB. This is especially true in orchards that have a good cover.

The hot dogging method was used to determine the level of ant activity within each block. A half-inch hot dog slice (Bar-S brand containing beef, pork, and chicken) was placed in a snap-cap vial; 15 vials were placed in each of three rows per block, with five vials in the center of the middle and five vials along each berm. After walking in 15 trees, vials were dropped every 11 trees. Vials were distributed in the orchard during early morning ant activity for duration of two hours, then picked up and stored in the freezer until counting. Sample processing involved removing ants from the hot dog and vial by washing them into a large petri dish for counting. All ants per vial were individually separated and counted.

Graph 11 shows the ant populations at four different sampling dates in both the reduced input and conventional blocks. There is a big difference in ant population between the reduced input and the conventional. From the first to the last sample, the conventional blocks show a reduced ant population. This may be due to the DiazinonÆ spray done in the dormant season. ClinchÆ was applied at a rate of one pound per acre on both reduced risk and conventional blocks. There was no reduction in the ant population due to the ClinchÆ treatment. By the time ClinchÆ was applied, the ant population was going down. There was a small recovery on the reduced input blocks, but not on the conventional.

**Graph 11. Average number of ants per-vial on both reduced and conventional blocks from four sampling dates**




## Yields

We decided to take yields from Nonpareil and Butte varieties from both reduced input and conventional blocks. The reasons for taking yields were to determine the influence of dormant oil and cover crop on productivity. Nonpareils were harvested on August 26, 1999 and Buttes were harvested on September 30, 1999. In both cases, three rows were selected at random from each of the reduced input and conventional blocks. This represents 21% of the Nonpareils and 26% of the Buttes in the entire trial. Typical commercial harvesting equipment was used. The nuts from each row were weighed on a 40,000-pound capacity platform scale. Two four-pound sub samples were taken from each load. Samples were gathered from the elevator as the load was being transferred to the truck.

The following table shows that there are no significant differences in Nonpareil or Butte kernel weights and/or yields (pounds per acre) between reduced input and conventional blocks.

**Nonpareil**

| | Weight of Kernel (g) | Yield (lbs/ac) |
|---|---|---|
| Reduced Input | 1.06 a* | 701 a |
| Conventional | 1.04 a | 794 a |

**Butte**

| | Weight of Kernel (g) | Yield (lbs/ac) |
|---|---|---|
| Reduced Input | .90 a | 804 a |
| Conventional | .90 a | 760 a |

(*Like letters indicate no significant difference between treatments).

### Reject Levels

Reject levels were determined from 16 different nut samples. Each block was sampled in four quadrants making our sample representative of the block. The kernels, once cracked, were examined for navel orangeworm, peach twig borer and ant damage. Table 3 shows the percent of insect damage from the reduced input and conventional.

**Table 3. Percent of navel orangeworm, peach twig borer, and ant damage to Nonpareil kernels**

| | %Percent Damage | | | |
|---|---|---|---|---|
| Treatment | Ants | NOW | PTB | Total |
| Reduced Input | 3.40 | 0.12 | 0.06 | 3.58 |
| Conventional | 1.86 | 0.19 | 0.26 | 2.31 |

The highest insect damage was on the reduced input treatment and most of the damage was due to ants. Table 4 shows the ant damage and mean ant numbers during the growing season.

**Table 4.**

| Treatments | % Damage | Mean Number of Ants | | | |
|---|---|---|---|---|---|
| | | 5-01 | 6-25 | 8-16 | 8-25 |
| Reduced Input | 3.40 | 89 | 170 | 81 | 100 |
| Conventional | 1.86 | 3 | 120 | 54 | 46 |

One of the explanations for the higher ant damage in the reduced input may be due to the higher ant populations in this treatment.

## ACKNOWLEDGEMENTS

We wish to thank Thomas Vetsch of Vetsch Farms of California, Inc., for providing and maintaining the study site, and for providing labor when needed. We appreciate the donation of predatory mites by Matt Billings of Sterling Nursery, and ClinchÆ ant bait by Roger Williams of Novartis. This study was supported by a grant from the California Almond Board Pest Management Alliance. Thank you for your support.

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|---|

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## Appendix B

1998 BIOS Insectary Mixî for almond orchard under stories. Seed at 12 lb per seeded acre

| Common Name | Species and Cultivar | %By Weight in Mixture |
|---|---|---|
| White Sweetclover | *Melilotus alba* cv ëHubamí (Annual Form) | 10 |
| Common Vetch | *Vicia sativa* | 17 |
| Subterranean Clovers (3-4 Varieties) | *Trifolium subterraneum* | 20 |
| Crimson Clover | *Trifolium incarnatum* | 8.3 |
| ëNitroí Persian Clover | *Trifolium resupinatum* | 5 |
| Cereal Rye | *Secale cereale* | 8.3 |
| Triticale | *Triticum aestivum X Secale cereale,* cv ëJuaní | 8.3 |
| Barley | *Hordeum vulgare* cv ëU.C. 476' | 8.3 |
| Sweet Alyssum | *Lobularia maritima* | 0.83 |
| Tidy Tips | *Layia platyglossa* | 0.83 |
| Coriander | *Coriandrum sativum* | 1.7 |
| Celery | *Apium graveolens* | 0.83 |
| Bishopís Weed | *Ammi majus* | 0.83 |
| Toothpick Weed | *Ammi visnaga* | 0.83 |
| Bee Phacelia | *Phacelia tanacetifolia* | 8.3 |
| Yarrow | *Achillea borealis* | 0.83 |

## VETSCH REDUCED INPUT TRIAL SYSTEMS COMPARISON 1999

## APPENDIX A

| | CONVENTIONAL | | | REDUCED INPUT | | |
|---|---|---|---|---|---|---|
| **Chemical** | **Date** | **Treatment** | **Rate** | **Date** | **Treatment** | **Rate** |
| Applications | | | | | | |
| Dormant | 1/4/99 | Diazinon | 5 pints/A | None | | |
| Bloom | 2/22/99 | Rovral (Sonoras only) | 1 lb./A | 2/21/99 | Rovral (Sonoras only) | 1 lb./A |
| May | None | | | None | | |
| Hullsplit | 7/10/99 | Imidan 70W (ECM) | 5 1/3 lbs./A, 200 GPA | 7/10/99 | Success | 6 oz./A, 200 GPA |
| Mites | 7/22/99 | Omite (EOM) | 12 pints/A | 7/19/99 | Predatory Mites | 2500/A |
| | | | | 8/11/99 | Predatory Mites | 2500/A |
| Ants | 7/28/99 | Clinch | 1 lb/A | 7/28/99 | Clinch | 1 lb./A |
| Weeds | | Roundup, Gramoxone | | | Roundup, Gramoxone | |
| Cover Crops | | Barley | 40 lbs./A | | Barley,<br>Insectary Mix<br>(every 11th middle) | 40 lbs./A<br>10 lbs./A |

EOM = Every other middle

Sanitation, pruning, irrigation, and harvest activities were the same in both systems.

Pest monitoring activities were the same in both systems. Average hours per acre = 2.8.

**APPENDIX #3**

**Butte County Almond PMA Project**
**Year –End Report December, 1999**

## INTRODUCTION

This orchard is approximately 49 acres. The grower standard block is 27 acres; the PMA block is 22 acres divided into a 12-acre soft treatment, and a 10-acre organophoshpate dormant treatment. Five of these 10 acres received an organophosphate hullsplit spray. Traps were placed in the center Nonpareil row on the north side of the same tree and monitored weekly.

### Treatment Before Monitoring

Conventional Practice 27 acres: On 2/20/99, and 2/26/99 a mixture of Rovral, oil, and 10-52-10 was applied. Rovral was applied at .8 pounds per acre. Oil was applied at 1 gallon, and 10-52-10 was applied at 4 pounds per acre. On 3/9/99 Break, at 4 ounces per acre, Condor at 2 pints per acre, and 20-20-20 at 4 pounds per acre was applied.

**Dormant Spray:** Diazinon was applied at 4 pints, Kocide applied at 8 pounds, and oil applied at 4 gallons per acre on 1/28/99.
**PMA 22.5 acres**: Rally and 10-52-10 was applied on 2/23/99, and 2/26/99 at rates of 6.4 ounces and 4 pounds per acre respectively.
**Soft 12.5 acres**: On 3/9/99 Vangard at a rate of 5 ounces, Condor at a rate of 2 pints, and 20-20-20 at a rate of 4 pounds per acre were applied.

**Weeds**: On 2/5/99 the strips were treated with Round up original at a rate of 2.66 pints per acre. Goal 2xC was also applied at this time at a rate of 6 ounces per acre.

### Peach Twig Borer

Dormant 100 spurs samples were taken in December 1998 from each of the four blocks and evaluated for peach twig borer hibernacula. No hibernacula were present in any of the blocks. Peach twig borer traps were placed in the Butte County Pest Management Alliance orchard on March 12, 1999. One trap was placed in each of the four blocks: grower standard, soft chemical, dormant spray, and dormant-hullsplit spray. Traps were monitored weekly, lures changed every two weeks, and liners changed as necessary. The first biofix occurred on April 22, 1999. Subsequent biofix dates are: June 26, August 13, and September 28 (Fig. 1). As of 9/16, seasonal totals of peach twig borer trap captures are presented in Table 1.

**Table 1. Seasonal peach twig borer trap captures as of 9/16/99**

| | Grower Standard | Soft | Dormant OP | Dormant + Hullsplit OP |
|---|---|---|---|---|
| **Peach twig borer** | 1344 | 1664 | 1163 | 1031 |

## Navel orangeworm

Navel orangeworm traps were placed in trees on May 6, 1999. The biofix for this orchard occurred on May 14, 1999. Since eggs were so rapidly detected on the traps, this biofix date may be inaccurate but will suffice for these purposes. On 7/16, 1025 DD, the second biofix occurred and on 8/27 at 1717 DD on new crop nuts, and on 9/15, 2050 DD, on mummies the third biofix occurred (fig. 2). Overall, there were very few eggs detected throughout the orchard. The total eggs trapped for the season in each plot are presented in Table 2. These low populations can be attributed to winter sanitation. Mummy counts taken in February 1999 showed that out of 20 randomly chosen trees in each block, totaling 80 trees, there was less than 1 nut per tree. Winter sanitation is the most effective means of controlling navel orangeworm.

### Table 2. Seasonal total of NOW eggs Butte Co. PMA 1999

| | Grower Standard | Soft | Dormant OP | Dormant + Hullsplit OP |
|---|---|---|---|---|
| Navel orangeworm eggs | 28 | 34 | 30 | 29 |

## San Jose Scale and San Jose Scale Parasite

Dormant spur samples showed that less than 10% had detectable scale or parasitized scale in each block. San Jose scale traps were placed in the orchard on March 12, 1999. New traps were placed in the tree weekly as the old traps were collected, wrapped in plastic wrap, and brought back to the laboratory to be evaluated under a microscope. The male scale and the parasites were counted using the random blocks provided on each trap. The first biofix for San Jose scale was on 4/16/99 and was observed again on 4/22/99. After this date, the male scale did not reappear on the traps until 7/13/99. Parasites were present starting on 6/8/99 in great numbers. The parasite trapping continued for the duration of the season despite the low number of male scale. Season totals show that the grower standard block had the least number of male scale and parasites. The dormant-hullsplit block had a season total of 85 scale but had the most parasites present with 3,335 total (Table 3).

**Table 3. Seasonal total of San Jose scale males and parasites trapped.**

| | Grower Standard | Soft | Dormant OP | Dormant-Hullsplit OP |
|---|---|---|---|---|
| San Jose Scale | 45 | 205 | 320 | 85 |
| *Prospaltella* | 1990 | 2385 | 2355 | 3335 |

## Mites

Dormant samples showed that over 50% of the spurs collected in each block had mite eggs present. Mite monitoring began on 6/23/99 and continued weekly until 8/31/99. Monitoring then occurred every other week. At each sampling, five trees per block were chosen randomly and fifteen leaves from each of the five were collected and inspected for red mites, two-spot mites, beneficial mites, and beneficial insects. Differentiation between two-spot mites and red mites were not noted. The total season count shows that the grower standard block had the least mites and the second highest number of beneficial insects observed (Table 4 and Fig. 3). There was an increase of mites and their predators noted on 9/16/99. Another sample was taken and showed there were no mites present. Since the population increase occurred late in the season, and defoliation was minimal, these mites will not be detrimental to tree performance next year.

**Table 4. Seasonal total of predator mites/beneficial insects, and european/two-spot mites**

| | Grower Standard | Soft | Dormant OP | Dormant + Hullsplit OP |
|---|---|---|---|---|
| **Predators and Beneficials** | 19 | 13 | 22 | 12 |
| **Mites** | 9 | 12 | 34 | 26 |

### Ants
Ant traps were placed in each block in the orchard on 8/11/99. Baited with dried almonds collected from the orchard, weekly monitoring detected no ant activity.

### Peach Twig Borer Shoot Strikes
Shoot strike monitoring began on 3/25/99 and continued weekly until 6/29/99. The first peach twig borer larva was found on 6/8/99. Preceding that, only oriental fruit moth larva were collected. At the end of the first generation, a more intensive sample was taken. No peach twig borer larvae were collected.

### Tree Bands
Five Nonpareil trees were randomly selected in the same row where traps were placed. Corrugated cardboard was stapled around the trunks and the main scaffolds. These bands were to be monitored at the end of the peach twig borer generation for the presence of pupae. Upon returning to the orchard it was discovered that the bands were shredded by local wildlife. They were replaced, but the bands were continuously shredded on a weekly basis. No data was collected from tree bands.

### Diseases
(shothole, scab, anthracnose)
Diseases were monitored by visual inspection and disease presence was to be reported immediately. There were no major disease outbreaks throughout the orchard this year.

### Harvest
Harvest samples were collected from Nonpareil trees in the trap row on August 31, 1999. Five trees were chosen and 100 almonds were collected totaling 500 almonds per block (2,000 almonds from the orchard—or twenty, 100 nut samples). Almonds were inspected for peach twig borer, navel orangeworm, and oriental fruit moth and ant damage. Damage observed is expressed in percent in Table 5. Quality was outstanding in all four blocks this year.

**Table 5. Harvest results from the Butte Co. Almond PMA site.**

| | Grower Standard | Soft | Dormant | Dormant + Hullsplit |
|---|---|---|---|---|
| **PTB** | .2% | .2% | 0 | 0 |
| **NOW** | 0 | 0 | .2% | 0 |
| **OFM** | 0 | 0 | 0 | 0 |
| **Ant** | .4% | 0 | 0 | .2% |

## RESULTS

The pest management program in this orchard has been implemented well. As of harvest, there is virtually no damage in any of the four treatment areas. However, in order to determine if there are differences in treatments, data must be collected for a number of seasons. We plan to continue this project in the same manner next year with little or no changes in procedure.

**Butte County Almond PMA Satellite NOW Project**

This is a replicated trial pertaining to the control of navel orangeworm. There are three replicated blocks of 20 acres each. Each block has 4 five-acre treatments. The treatments included hullsplit sprays of Lorsban, Success, Stealth, and a control. Shortly after the Stealth application, almonds were evaluated for the presence of navel orangeworm eggs and worms. One hundred almonds were sampled from one of the control blocks and also from each of two of the Stealth blocks on 8/3/99. Results from this initial evaluation are presented in Table 6.

**Table 6. Percent of NOW in each treatment on 8/3/99**

| | Control 1 | Stealth 1 | Stealth 2 |
|---|---|---|---|
| **NOW Eggs** | 2% | 3% | 2% |
| **NOW Worms** | 0 | 1% | 1% |

Navel orangeworm traps were also placed in the middle of these 3 treatments and traps were checked weekly. On 9/9/99, five, one hundred nut samples were collected from each treatment in each block. Five Nonpareil trees were randomly selected from the center row in each plot. In a similar fashion a follow-up sample was collected from the Harvey variety on 9/17/99. At that time, two hundred nuts were collected from each treatment in each block. Almonds were evaluated for oriental fruit moth damage, navel orangeworm damage, peach twig borer damage, and ant damage. The results presented in the tables below reflect navel orangeworm damage only. Navel orangeworm harvest data is presented in Table 7 for the Nonpareil results and Table 8 for the Harvey results.

**Table 7. NOW harvest damage of Nonpareil variety.**

| Treatment/ Replication | Lorsban | Success | Stealth | Check |
|---|---|---|---|---|
| 1 | .2% | .2% | .2% | .4% |
| 2 | .4% | .2% | .2% | .2% |
| 3 | .4% | .2% | 0 | .2% |

**Table 8. NOW harvest damage of Harvey variety.**

| Treatment/ Damage Area | Lorsban | Success | Stealth | Check |
|---|---|---|---|---|
| **Hull** | 9.2% | 8.2% | 6% | 10.7% |
| **Meat** | .8% | .67% | 1% | 1.2% |

## RESULTS

The satellite project has produced an interesting trend in navel orangeworm control. There was very little damage at harvest in the Nonpareil variety in the treatments or the replicates, however the damage of the Harvey variety is substantially higher. This project should be replicated again next season in order to adequately determine the best form of control for the navel orangeworm.

**Plans for Year 2:**

Both projects have been implemented quite effectively and thoroughly. We plan to continue for the following year with little or no modifications in protocol. A project that continues data collection and monitoring over the course of many seasons, will allow more insight to environmentally friendly means of pest control in California almonds.

**FINAL REPORT SIGN-OFF SHEET**

| | |
|---|---|
| This report was approved by the contract manager | **Contract Manager**<br>**Date:** |
| This report was scanned for virus, and copied to the I drive. A photocopy was made for Anne.(disk is filed in grants cabinet) | Sewell Simmons<br>**Sewell Simmons**<br>**Date:** 2/2/2000 |
| This report has been formatted, and edited for any obvious errors, (not to include any content changes.) | Anne M. Mox<br>**Anne Mox**<br>**Date:** 2-2-2000 |

h: Mox/Alliance Final Reports/Contract 97-0281

| | |
|---|---|
| This report is ready to be placed on the web. | **Sewell Simmons**<br>**Date:** |